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Open File Report 86-7

OIL SHALE ASSESSMENT OF THE ALBERT FORMATION IN THE ROSEVALE AREA OF ALBERT COUNTY, NEW BRUNSWICK

by

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Canada-New Brunswick Mineral Development Agreement
Entente Canada-Nouveau-Brunswick L'Exploitation Minérale

Forests, Mines and Energy New Brunswick
Forêts, Mines et Énergie Nouveau-Brunswick
Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

86-05494/

This report has been prepared for:

Mineral Resources Division
Department of Forests, Mines and Energy
New Brunswick

Hon. Malcolm N. MacLeod, Minister

1986

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This project was funded under the Canada-New Brunswick Mineral Development Agreement, a subsidiary agreement under the Economic and Regional Development Agreement.

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1986

Report No.: Open File Report 86-7

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Catalogue No.: ISSN 0712-4562

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ABSTRACT

Assessment of the oil shales of the Albert Formation near Rosevale, Albert County, New Brunswick, by K.D.A. Whaley under contract from the New Brunswick Department of Forests, Mines and Energy involved initially a reveiw of the local history of oil shale exploration, a description of the Albert Formation and its depositional sub-environments in the Moncton Subbasin, and a geological compilation of the Rosevale area.

The geological compilation indicated high-yielding oil shale beds in the area of Bray Brook. Hence, six holes were put down to test these beds. A total of 928 m of NQ core was recovered and lithologically logged at a scale of 1cm to 1m.

The core intersections include five distinct lithologies; shale, siltstone, sandstone, intraformation conglomerate, and polymictic conglomerate. The shale displays laminations or varves of carbonate (calcite and dolomite), silicate minerals, and kerogen. The siltstone beds are laminated to massive and contain less kerogen than the shale. The finer grained sandstones contain disseminated kerogen. Intraformational conglomerates contain clasts of kerogenous shale and siltstone, whereas the polymictic conglomerates contain abundant pre-Carboniferous detritus.

Relative density (gamma-gamma) or apparent density, neutron-neutron (porosity), natural gamma, and resistivity were run on each hole. The density logs assisted in locating oil shale beds and in estimating the relative quantity of kerogen present. The porosity log effectively delimited sandstones beds. The resistivity log provided indentification of non-kerogenous shales and siltstones.

Five hundred and five samples of core, comprising a total length of 356.5 m, were cut from the organic rich shales and siltstones. The samples were tested by Rock-Eval pyrolysis and for total carbon, and organic carbonate carbon.

The analytical result in conjunction with the geological interpretation of the deposit indicates that 4,400,000 t of oil shale yielding approximately 100 l/t shale oil to a depth of 100m occur in the Bray Brook Zone. The zone has a surface strike length of 900 m and an average thickness of approximately 15 m and contains 27% dolomite equivalent. The tonnage of the zone could be substantially increased by lowering the cut-off grade or by including reserves to a greater depth.

Two other areas within 1 km of the Bray Brook Zone were outlined where the potential for kerogen rich shales needs further assessment.

OIL SHALE ASSESSMENT OF THE ALBERT FORMATION IN THE ROSEVALE AREA OF ALBERT COUNTY, NEW BRUNSWICK

I) INTRODUCTION

Oil shale has been known as a potential source of petroleum products for approximately 140 years. The term "oil shale" refers to a sequence of rocks ranging from shale to very fine-grained sandstone that may be calcareous or dolomitic. A black to brown solid organic substance derived from decaying algal matter was preserved in these sediments. The mineraloid term for this organic substance is "kerogen".

The extraction of liquid fuel from oil shale is accomplished by employing a destructive distillation process known as "retorting", which is costly relative to conventional crude production. Recent technological advances have taken advantage of two components of oil shale: (1) kerogen, and (2) carbonate minerals (dolomite and calcite). The shale will burn when blended with coal to provide a supplementary source of energy and the carbonate minerals provide an environmental filtering agent to absorb sulphur oxide gases expelled from the burning coal. A demonstration plant has been constructed in Chatham, New Brunswick to test the feasibility of the co-combustion process.

Many occurrences of oil shale are located in Canada (Figure 1), with the more kerogenous oil shale deposits found in the elongated Carboniferous sedimentary basin stretching across New Brunswick, Nova Scotia and western Newfoundland. The Albert Formation in the vicinity of Moncton, New Brunswick is one of the best known and most explored oil shale areas in Canada.

The oil shale assessment undertaken at Rosevale during the fall of 1985 and winter of 1986 was carried out to determine the volume, quality (l/t) and carbonate content of oil shale in that area. Rosevale is located 14 km west-southwest of the village of Hillsborough along Route 910 in southeastern New Brunswick (Figure 2).

The Rosevale area was selected from several prospective oil shale sites by the New Brunswick Department of Forests, Mines and Energy. From 1982 to 1984, the Department conducted a bedrock mapping program coincident with an organic geochemical rock sampling program to evaluate the oil shale occurrences of the Albert Formation. The organic geochemical results from the Rosevale area were very encouraging and were enhanced by historical geochemical data, particularly data compiled from a Federal Government drilling program undertaken in 1942. The geological mapping program also demonstrated the relatively simple, north-dipping structure of the oil shale beds in the Rosevale area. The location was also assessed for possible problems related to access, water supply, water diversion and land acquisition. No serious deterrents were anticipated.

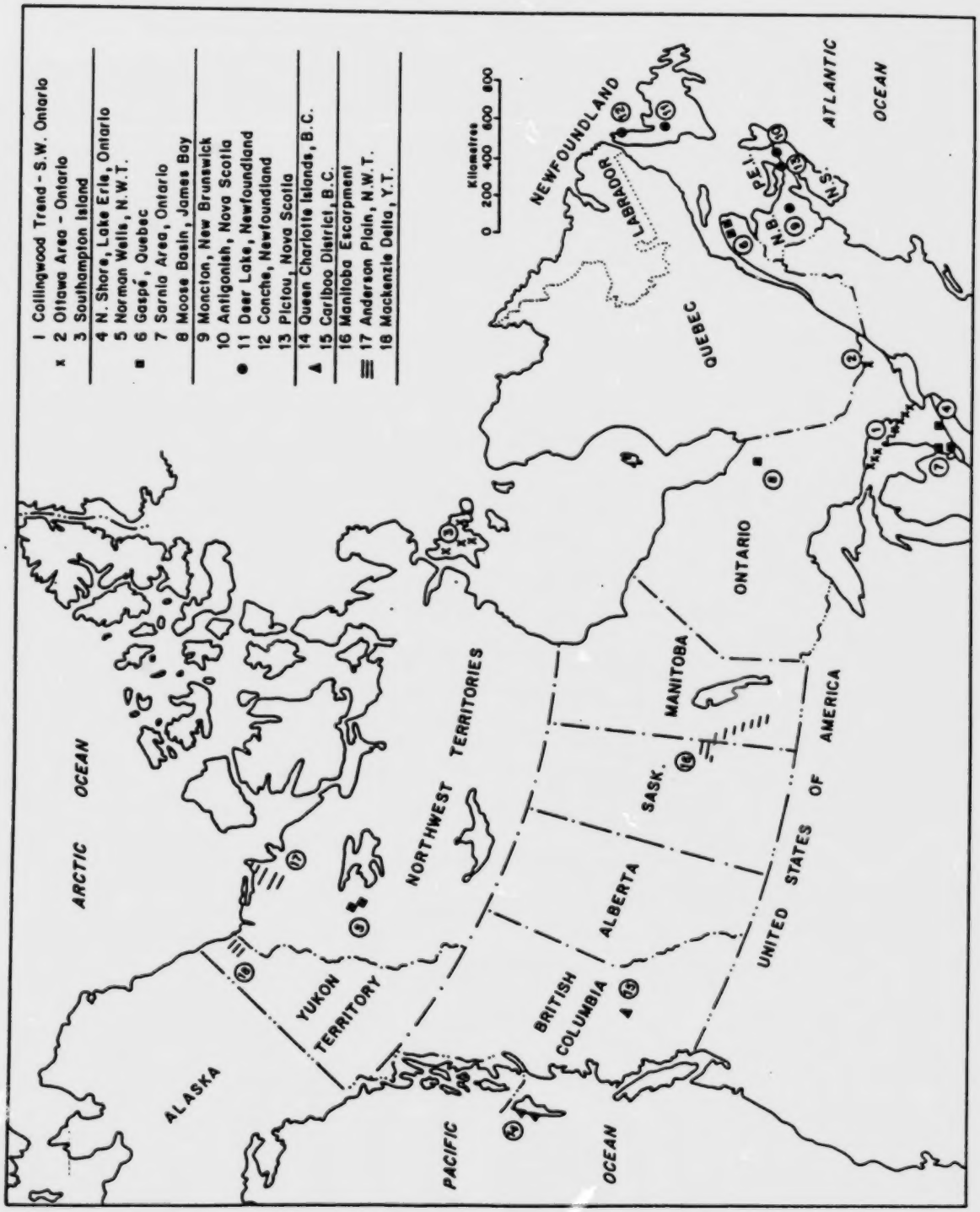


Figure 1 Principle oil shale deposits of Canada. After Macauley (1981)

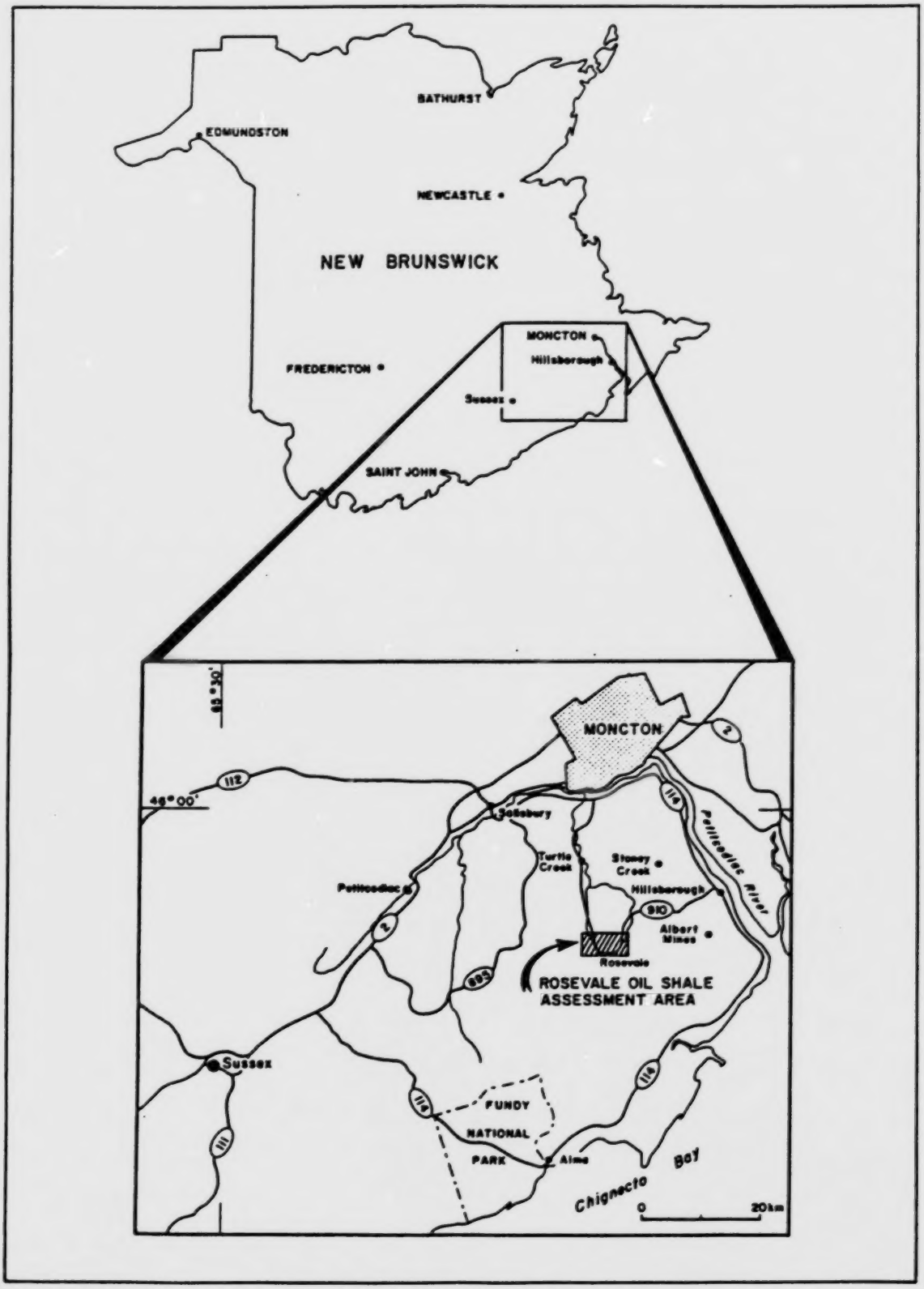


Figure 2 Location map for Rosevale oil shale assessment

This Rosevale assessment included a geological compilation, drilling of six exploration holes, geophysical logging, lithologic logging and organic geochemical analysis. Data collected while performing these surveys were plotted and interpreted to produce geological cross sections and to facilitate ore calculations. The kerogenous beds of the Rosevale area have been well documented; however, no quantitative studies were previously undertaken.

Two suites of oil shale beds with significant organic content were found. The major focus was placed on the Bray Brook Zone which lies in the southern part of the project area, and contains 4,400,000 t of oil shale yielding approximately 100 l/t shale oil. The carbonate minerals have a combined average content of 36 %. The Bray Brook Zone has a strike length of approximately 900 m.

The Baisley Brook Zone, which strikes across the northern part of the project area, was not studied in detail because of the limits placed on the amount of drilling allocated to the project.

II) HISTORY

Scotland was the first country to exploit oil shales for extraction of liquid petroleum products. Torbanite, a type of algal coal, was retorted initially because it provided a high shale oil yield. The torbanite deposit was exhausted by 1850 and

the focus was then turned to associated oil shale deposits (Ells, 1909).

In Canada, oil shale was first retorted near Craiglieth, Ontario, on Lake Huron (Macauley, 1981). This operation commenced in 1859 but closed the following year when cheaper conventional crude was discovered at Petrolia. In Nova Scotia, attempts at shale oil production in the early twentieth century also failed due to the adverse economics of the retorting process.

Beds of the Albert Formation, located between Urney and Taylor Village in southern New Brunswick, contain the most promising lacustrine oil shale deposits in Canada (Macauley, 1981). The grade of the Albert oil shale is similar to that of oil shales found in Scotland, and the mode of occurrence is similar to the Green River Formation in parts of Colorado, Utah and Wyoming, U.S.A.

The lacustrine depositional environment of the Albert sediments was first implied by Lambe (1909, 1910) when he determined that the fish fossils found in the area could have fresh water or marine origins. Greiner (1962) concluded that the lacustrine model was correct and used characteristics of both ancient and modern examples to verify his conclusion.

In 1849, the discovery of an albertite vein by Mr. John Duffie on the bank of Frederick Brook near Albert Mines (Figure 2) initiated interest in oil shale in New Brunswick. Albertite is

a black vitreous solid bitumen thought to be derived from the thermal maturation of associated oil shales (king, 1963). The vein (Figure 2) became controversial following its discovery when Mr. Cairns claimed the rights to the deposit because of his rights to coal in the region. Dr. Gesner ascertained that albertite was not related to coal. Although the courts ruled in favour of Cairns, much information gathered during the trial indicated that the mode of occurrence of albertite did not conform to that of coal deposits. Testimony by many expert witnesses led to early comprehensive documentation of the albertite deposit. It was noted that the mineralization was epigenetic and related to the oil shales rather than coal. Between 1863 and 1876 the vein produced approximately 70,370 t of Albertite ore containing approximately 500 l/t shale oil and 455 m^3/t gas (Macauley, 1981; Carter and Shaw, 1979).

Evidence of an early attempt at exploiting oil shale in the Baltimore-Rosevale area was documented by L.W. Bailey (1864) after he toured a number of oil shale occurrences. He reported on an abandoned experimental retort near Baltimore (Plate 86-161). He also described the varved and slumped bedding common to the higher grade oil shale beds.

In 1907, a bulk sample of 41 to 45.5 t of oil shale was selectively sampled from various tunnels in the Rosevale area. This experimental sample was shipped to the Pumpherston Oil Company Limited retort in Glasgow, Scotland for processing and, in the following year, Dr. R.W. Ells (1909) reported favourably

on the retort results. At the same time, individual samples were also collected from outcrops and tunnels where oil shale was exposed. It was determined that good quality oil shales were present in this region of New Brunswick. The bulk sample tests resulted in yields of approximately 200 l/t shale oil and 38.5 kg/t ammonium sulphate.

W.J. Wright (1922) summarized information on the oil shale deposits in the Albert Mines and Rosevale areas of New Brunswick. He recorded the location of drill holes and tunnels, and results of shale oil yield tests conducted on oil shale samples from the Rosevale area. Areas with a concentration of drill holes and tunnels may be an indication of higher grade oil shale beds (Plate 86-161). Wright also reported on an experimental retort that operated for approximately 9 months and yielded an average of 185 l/t shale oil and 30 kg/t ammonium sulphate.

In 1927, Maritime Eduction Co. Ltd. constructed an experimental retort near Rosevale (Plate 86-161) but declared bankruptcy the following year. The rate at which shale could be mined and processed, and the rate of shale oil recovery was not sufficient to be economical (Carter and Shaw, 1979).

Wright (1922) divided the rocks of the Moncton Subbasin into five 'series'. The Albert series of Wright was redefined as the Albert Formation by Norman in 1932. As part of this work, Norman also named the underlying Memramcook Formation and developed guidelines for locating the boundaries between the

Albert Formation, the underlying Memramcook Formation and the overlying Weldon Formation. The Weldon Formation has recently been redefined as the Weldon Member of the Moncton Formation (Pickerill and Carter, 1985)

The uncertainty of crude oil supplies during World War II initiated a search for domestic petroleum resources. In 1942, the Canada Department of Mines and Resources undertook an oil shale investigation, which consisted of 36 drill holes in the Rosevale area, 36 holes at Albert Mines and 7 holes at Taylor Village. The program was conducted to determine the amount and yield of the oil shale in southern New Brunswick. Reserves were calculated for the Albert Mines area (Timm et al., 1948). Shale oil yields from the three areas tested were not sufficient to warrant continued exploration after conventional petroleum production caught up with demand during the latter stages of the war. Systematic sampling and geochemical testing (Fischer Assay) of continuous sections of oil shale core from 1942 drilling failed to reproduce the results reported by Ells (1909). In all probability, the bulk sample reported by Ells was a collection of optimal samples from oil shale exposures and tunnel intersections in the Rosevale area. This emphasizes the importance of proper sampling techniques in evaluating oil shale reserves. The Rosevale drill-hole locations from the 1942 oil shale investigation are shown on Plate 86-161.

Gussow (1953), with his regional geological synthesis, provided the first significant contribution to geological

interpretation of the Moncton Subbasin since Norman (1932; 1941). Following this, Dr. H. Greiner (1962) completed a geological interpretation of the depositional environment of the Albert Formation and adapted the three zones of the Albert series reported by Norman (1932). The three zones were renamed the Hiram Brook, Frederick Brook and Dawson Settlement members. Previously, correlation of rock units within the Albert was based on six "driller's sands" (Norman, 1932; Howie, 1965) that were identified and interpreted effectively within the Stoney Creek oil field. This method of correlation was not effective outside the Stoney Creek oil field.

Greiner (1977) also studied species of fish fossils and possible microfossils, and confirmed and expanded on the fossil identification work of Lambe (1909, 1910).

In 1967 and 1968, Atlantic Richfield Company conducted a limited exploration program of ten deep drill-holes to evaluate the oil shales at depth. Macauley and Ball (1982, page 71) indicate a low average shale oil yield for rocks of the Frederick Brook Member of the Albert Formation in the Rosevale area.

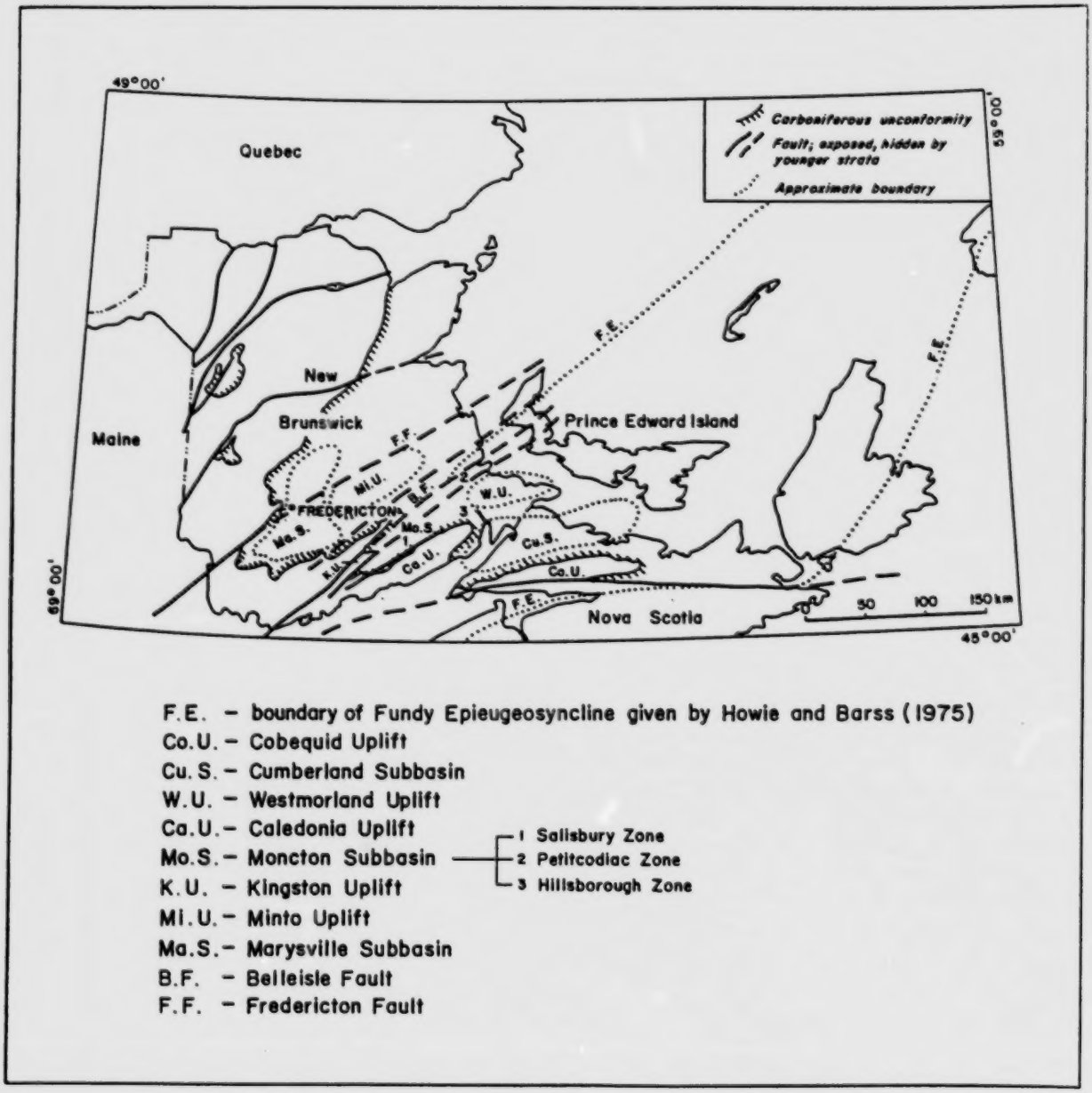
When oil prices began to rise in the 1970s, there was renewed interest in oil shale as an alternate source of petroleum. In 1975, Canadian Occidental Petroleum Ltd. commissioned Fundy Geoservices Ltd., under the guidance of J. Worth, to do a regional oil shale evaluation. Worth (1975) produced a geological map and recommendations for drill locations to evaluate the oil shale potential along the southern flank of

the Moncton Subbasin. Worth (1977) produced a summary report on results from the program. Pickerill and Carter (1980) produced a geological compilation map of the Moncton Subbasin and a sedimentological and depositional history report on the Albert Formation, which incorporated the recent information.

The results of this oil shale resource assessment and data from previous exploration programs in the Rosevale area are utilized to calculate potential oil shale reserves with an average grade of 100 l/t.

III) REGIONAL GEOLOGICAL SETTING

The Carboniferous sediments of Eastern Canada are deposited in an elongate basin called the Fundy Epieugeosyncline (Howie and Barss, 1975). The structure is referred to as the Fundy Basin in this report (Belt, 1968). The basin occupies approximately 16,700,000 ha and underlies parts of southern Gaspe, eastern New Brunswick, Prince Edward Island, northern mainland Nova Scotia, parts of Cape Breton Island and a narrow northeast-trending graben in western Newfoundland (Figure 3). Approximately 10,300,000 ha of the Fundy Basin underlie the Gulf of St. Lawrence.



F.E. – boundary of Fundy Epieugeosyncline given by Howie and Barss (1975)
Co.U. – Cobequid Uplift
Cu.S. – Cumberland Subbasin
W.U. – Westmorland Uplift
Ca.U. – Caledonia Uplift
Mo.S. – Moncton Subbasin
- 1 Salisbury Zone
- 2 Petitcodiac Zone
- 3 Hillsborough Zone

K.U. – Kingston Uplift
Mi.U. – Minto Uplift
Ma.S. – Marysville Subbasin
B.F. – Belleisle Fault
F.F. – Fredericton Fault

Figure 3 Major faults, uplands and subbasins in the southwestern Fundy Epieugeosyncline. After Worth (1977), and Howie and Barss (1975)

The Fundy Basin comprises a number of uplifts (horsts) and subbasins (grabens) which were formed by either normal or strike-slip faults during the latter stages of the Acadian Orogeny (Howie and Barss, 1975). Deposition began as early as Upper Devonian (Famennian) and continued until the Permian. The basal sediments of the basin were deposited on a basement of Precambrian to Devonian rocks that include felsic and mafic meta volcanics, meta sediments and granitoid to dioritic intrusives. The basement rocks have undergone varying degrees of regional and contact metamorphism; locally they have been intensely deformed by faults. The contact between the basement and overlying rocks is represented by an angular unconformity that is in many places offset by faults.

Worth (1975) divided the Moncton Subbasin into three depositional zones based on the distribution of Horton and Windsor Group rocks: the Petitcodiac Subbasin to the north, the Hillsborough Subbasin to the south and the Salisbury Subbasin to the west of the Westmorland Uplift (Figures 3). In this report, Worth's term "Subbasin" has been changed to "Zone" for purposes of clarity. This terminology will be used to facilitate the description of feature locations in the Moncton Subbasin.

The late Devonian and Mississippian strata in the Fundy Basin are deformed and in many places, particularly within the Moncton Subbasin, unconformably overlain by undisturbed Pennsylvanian beds. The complex evolution of the basin, indicated by interfingering of the rock types, has led to errors in

stratagraphic designations and much confusion in nomenclature (Pickerill and Carter, 1980).

The sediments deposited in the Fundy Basin are predominantly nonmarine. Sedimentation began with deposition of the Horton Group - a thick, principally fluvial and alluvial red bed sequence. The Horton Group beds are overlain by the Windsor Group evaporites which comprise the only recognizable marine strata in the Fundy Basin. The Hopewell and Canso Group strata signify the recommencement of nonmarine deposition in a second red bed cycle (Table 1, and Figure 4).

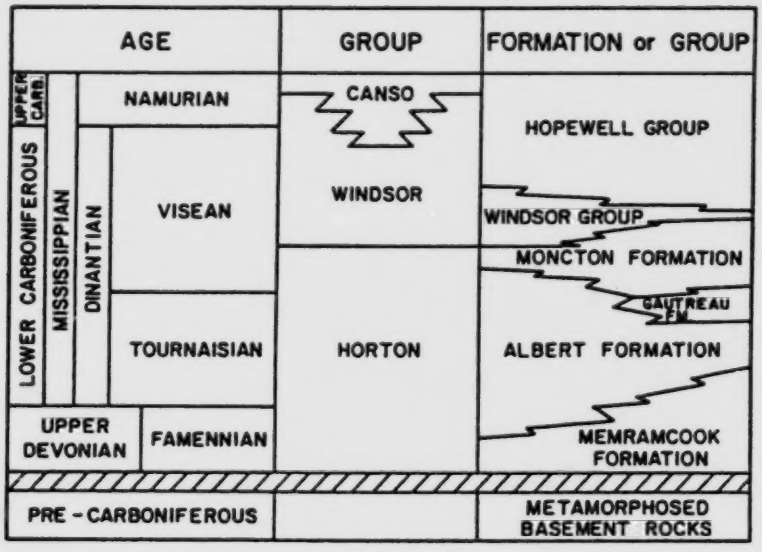


Table 1 Generalized table of formations for the Canso, Windsor and Horton Groups of New Brunswick. Modified after Greiner (1974), McCutcheon (1978) and Pickerill et al.(1985)

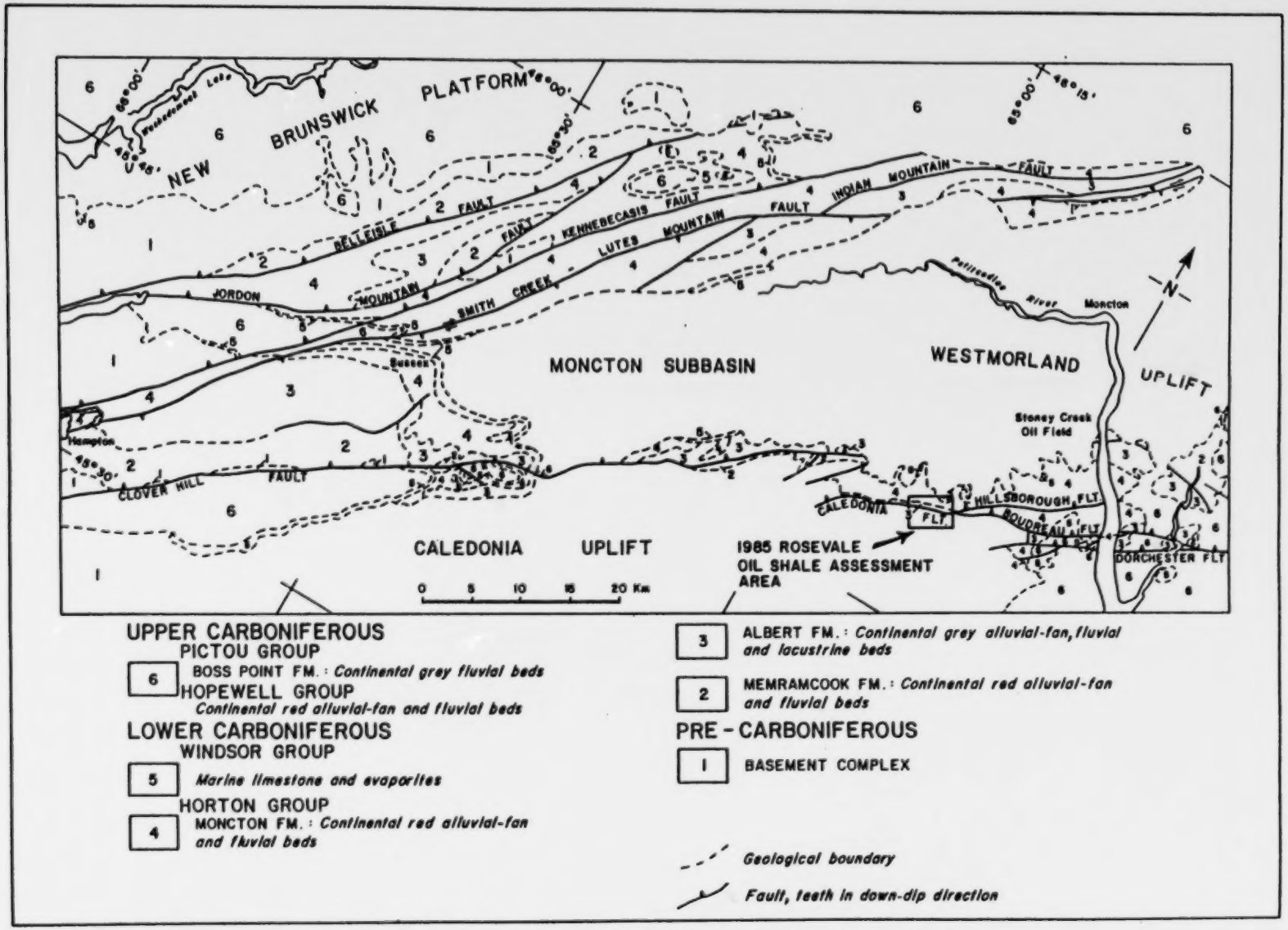


Figure 4 Simplified geology of Moncton Subbasin. After St Peter, (1982) and Pickerill et al. (1985)

The Memramcook Formation, at the base of the Horton Group, lies with angular unconformity on the pre-Carboniferous basement. It consists of coarse-grained, red to green, poorly sorted conglomerate and sandstone that gradually passes into reddish sandstones and siltstones toward the basin centre. Miospores from the formation, which were dated by Hacquebard (1972), indicate an Upper Devonian (Famennian) age in the Memramcook area. The sequence is a red bed facies deposited in alluvial and fluvial environments.

The Albert Formation is exposed along the rim of the Moncton Subbasin where it interfingers with and overlies the Memramcook Formation. The sediments of the Albert include fluvial, deltaic and lacustrine grey sandstones, siltstones, shales, and brown kerogenous shales, siltstones and fine-grained sandstones. The formation also contains alluvial-fan and fluvial conglomerate, sandstone and mudstone, and minor evaporitic limestone, anhydrite and glauberite (Pickerill and Carter, 1980; Greiner, 1962). The Albert strata display slump folds, ripple marks, synsedimentary faults, mudcracks, rain prints (Pickerill and Carter, 1980, page 56) sedimentary dykes and varved bedding (parallel laminations). Plant detritus, fish, fish scales, fecal pellets and microfossils are common (Lambe, 1909, 1910; Greiner, 1962, 1977; Varma, 1969). Spores identified by Hacquebard (1972) indicate that the Albert was deposited during Upper Devonian (Famennian) and Lower Carboniferous (Tournaisian).

The Albert Formation is conformably overlain by the Moncton Formation. The Moncton Formation (the uppermost formation in the Horton Group) comprises the basal Weldon Member and upper Hillsborough Member (Pickerill and Carter, 1985). The Weldon Member is composed of red to green, coarse conglomerate, sandstone, siltstone, and shale. The coarse-grained rocks are mainly restricted to the flank of the Caledonia Uplift (Figure 4). The fine-grained beds of the Weldon Member are dominantly red to chocolate brown siltstones and shales that locally contain calcareous nodules and caliche deposits. Common sedimentary features are: asymmetric ripples, dewatering features, rain prints and mudcracks. Some fine-grained beds show bioturbation.

The Weldon Member of the Moncton Formation is commonly overlain by the Hillsborough Member. Near the margin of the Moncton Subbasin the Hillsborough Member lies with angular discordance on the Weldon Member but in the central part of the subbasin the contact is believed to be conformable. The Hillsborough Member is composed of dark maroon to red to green conglomerates and sandstones. The conglomerates are commonly poorly sorted, and contain angular to subangular fragments of meta sedimentary, meta volcanic and plutonic rocks that are similar to the rocks comprising the Caledonia Uplift (McLeod, 1978; Pickerill and Carter, 1980). Like the Weldon, the Hillsborough tends to be finer grained in the central part of the Moncton Subbasin.

The Windsor Group conformably overlies the Hillsborough Member of the Moncton Formation. In places near the margin of the Moncton Subbasin, the Windsor lies directly on pre-Carboniferous basement (McCutcheon, 1981). The Windsor Group was deposited during a marine incursion into the Fundy Basin in Early Carboniferous (Visean) time. A shallow marine environment is indicated by brachiopod-bearing carbonate beds, algal-laminated carbonates, and widespread gypsum and salt deposits.

The Hopewell Group was laid down upon the Windsor Group. The Hopewell marks the beginning of a second clastic red bed cycle of deposition, which was temporarily interrupted by a period of intense folding and faulting in Late Mississippian to Early Pennsylvanian time (van de Poll, 1970; Gussow, 1953). The upper Hopewell rocks (Enrage Formation) lie with angular discordance upon lower Hopewell and older strata. The Hopewell Group is overlain by fluvial deposits of the Pennsylvanian Boss Point Formation and the Pictou Group (Gussow, 1953).

IV THE ALBERT FORMATION OF THE MONCTON SUBBASIN

A) GEOLOGY

The Albert Formation is a lacustrine sedimentary sequence exposed along the perimeter of the Moncton Subbasin (Figure 5). These sediments consist of calcareous and dolomitic grey shales, siltstones, sandstones, brown kerogenous shales and minor conglomerates. Arkosic siltstones, sandstones and local

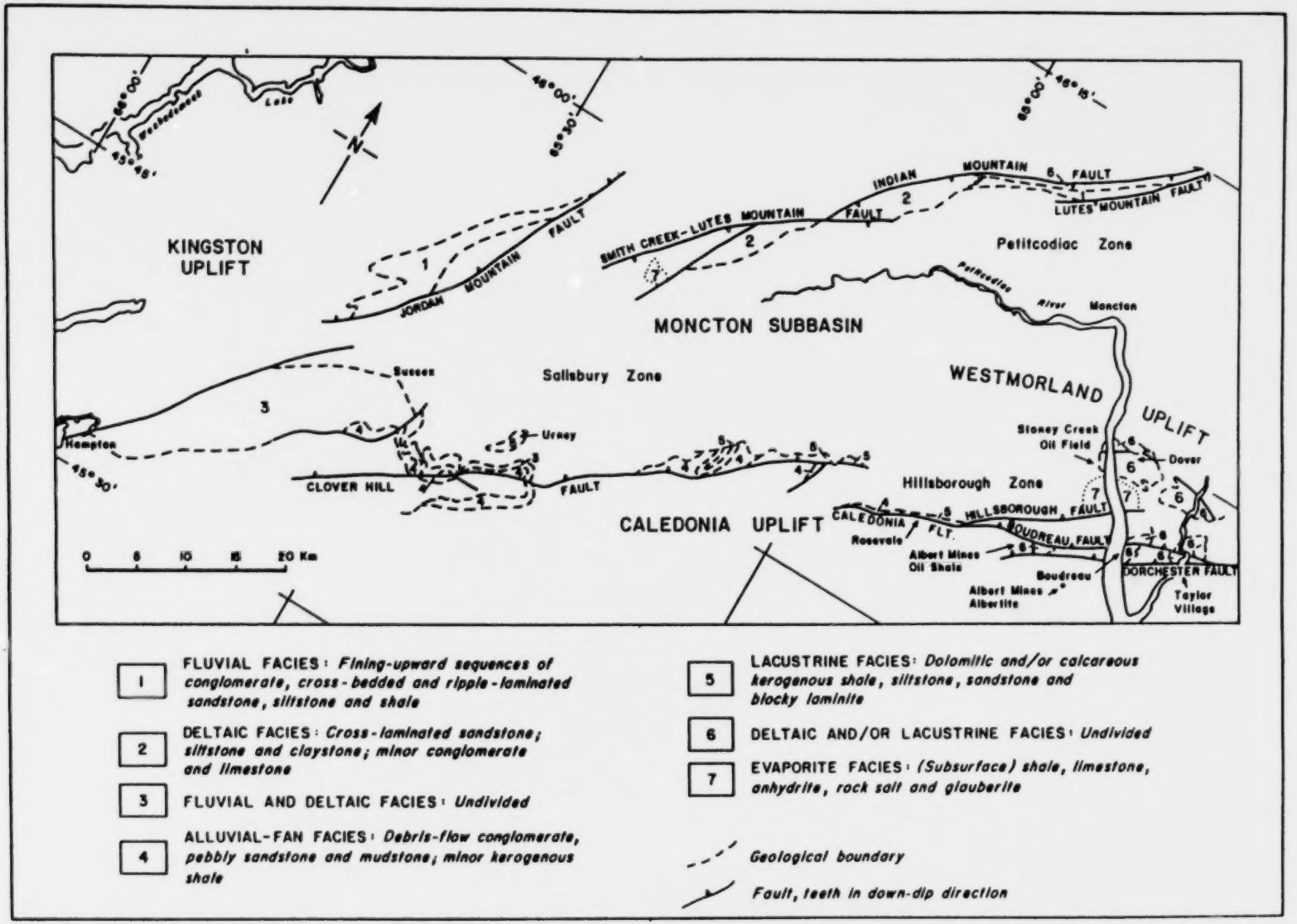


Figure 5 Albert Formation facies, Moncton Subbasin. After St Peter (1982) and Worth (1977)

evaporites are also present. The grey to brown Albert Formation is differentiated from the underlying Memramcook Formation and the overlying Moncton Formation by the distinctive red to green colouration. The contacts between the formations are conformable and gradational, making the position chosen for the contacts somewhat arbitrary. Contacts located through previous surface-mapping programs were established where the dominant rock type changed. This led to a dominant colour change as well. In core logging, the contact between the Albert Formation and overlying and underlying formations of the Horton Group were fixed at the occurrence of the first red or green bed.

Along the Caledonia Uplift, the three formations comprising the Horton Group may become lateral facies changes of one another (Pickerill and Carter, 1980, page 21). In the Rosevale area, the Albert Formation is apparently deposited unconformably upon the Caledonia Uplift; the Memramcook Formation is missing (Pickerill and Carter, 1980). This is believed to have been caused by the onlap of the Albert Formation and continuing subsidence of the Moncton Subbasin following Memramcook deposition.

A system of stratigraphic nomenclature for the Albert Formation was developed in the early twentieth century by New Brunswick Gas and Oil Company drillers when drilling the Stoney Creek gas and oil field. The system is based on the presence of six oil- and gas-bearing zones. Five of the beds are sandstones and one, 'driller's sand V', is a kerogenous shale. This system

is used successfully within the Stoney Creek field but is difficult to apply regionally to the Albert Formation.

Greiner (1962) and Wright (1922) divided the Albert Formation (Series) into three distinct members (zones). Greiner concluded that 'driller's sand V' was the only rock assemblage that could be traced with confidence outside the Stoney Creek field. He named the three members in ascending order: the Dawson Settlement Member, the Frederick Brook Member (representing 'driller sand V'), and the Hiram Brook Member. Varma (1969) divided the Albert Formation into similar lithologic units based on spore assemblages. For the purposes of general discussion, the author has accepted the three-member division of the Albert Formation as proposed by Greiner (1962).

The basal Dawson Settlement Member has generally gradational contacts with the underlying Memramcook Formation and the overlying Frederick Brook Member of the Albert Formation. The rock types present in the Dawson Settlement Member are grey calcareous and dolomitic sandstones, siltstones and shales. Kerogenous shales and mudstones are rare or absent. Lateral and vertical facies changes are common.

The Frederick Brook Member is primarly composed of calcareous and dolomitic brown to buff kerogenous shales, siltstones and fine-grained sandstones interbedded with grey to dark grey siltstones and sandstones. The shales are commonly thinly laminated, papery, flexible, and show slumping and synsedimentary faulting. The shale and siltstone beds also

contain numerous well-preserved palaeoniscid fish fossils, fish remains, fish scales and fecal pellets. Bioturbation is present but not common. The upper and lower contacts of this member are usually gradational and therefore the boundary is arbitarily placed where the dominant rock type begins to change. The average thickness is believed to be approximately 180 m (Greiner, 1962; Pickerill and Carter, 1980).

The uppermost member of the Albert Formation is the Hiram Brook Member, which is composed of predominantly grey calcareous and dolomitic sandstones, siltstones and shales. Thin beds of kerogenous shale are also present. The Hiram Brook Member is bounded by the Frederick Brook Member below and the Moncton Formation above (Greiner, 1962). Drill-core lithologic studies reported by Greiner (1962) indicate that the Hiram Brook beds exhibit rapid vertical and horizontal facies changes thath make correlation between areas difficult. The average thickness of the Hiram Brook Member is believed to be approximately 670 m.

B) DEPOSITIONAL SUBENVIRONMENTS OF THE ALBERT FORMATION

The Albert strata are interpreted as lacustrine deposits (Greiner, 1962). Pickerill and Carter (1980) have grouped these deposits into seven subenvironments. They are summarized below, with special emphasis on those subenvironments containing kerogenous beds (oil shales). For a more detailed discussion of the subenvironments of the Albert Formation the reader is referred to Worth (1977), Pickerill and Carter (1980), and Pickerill, et al. (1985).

Three subenvironments of the Albert Formation that are known to contain kerogenous shales, siltstones and mudstones are: (1) the carbonate-flat, (2) the marginal open-lacustrine, and (3) the central open-lacustrine.

The carbonate-flat subenvironment is composed of mudstones, sandstones, siltstones, dolomitic siltstones and dolomitic shales. The beds are commonly grey to grey-brown but may contain brown to dark brown kerogenous interbeds. The sediments range from massive to thinly bedded, with kerogenous shale beds commonly showing thin laminations. Plant detritus, fish scales, fish parts and evidence of bioturbation are common. The most characteristic sedimentary feature is rip-up clast or sedimentary breccia, which occurs in thin layers within siltstone and shale beds. Mudcracks, rainprints, and blebs or nodules of pyrite are also present. The beds associated with this subenvironment may be intercalated with marginal open-lacustrine and interdeltaic sediments. The major carbonate mineral formed in the carbonate-flat subenvironment is dolomite (Pickerill and Carter, 1980).

The marginal open-lacustrine subenvironment is mainly composed of mudstone, shale, kerogenous shale, minor dolomitic shale, limestone, siltstone and sandstone. The finer grained lithotypes are typically light to dark brown with sandstone and some siltstone beds being grey to dark grey. The shales and siltstones are thinly laminated and contain thin massive inter-beds and stringers of siltstone and sandstone. The fine-grained beds

are characterized by penecontemporaneous slumping and syn-sedimentary microfaulting. Some beds show weak to moderate bioturbation. Fish scales and plant detritus are common along bedding planes. The sediments common to this sub- environment are transitional between the marginal carbonate-flat and the central open-lacustrine subenvironments.

The central open-lacustrine subenvironment is best developed along the southern margin of the Moncton Subbasin. It is mainly composed of shale and siltstone, with minor beds of sandstone. The shale and siltstone beds are typically brown to brownish black, moderately to highly kerogenous, and calcareous or dolomitic. The sandstones are grey, calcareous and generally massive. The siltstones and particularly the shales are thinly to very thinly laminated. The beds are commonly varved and comprise alternating couplets of organic material and clay or carbonate minerals (King, 1963). Convoluted or slumped bedding is common. Fish scales, complete fish fossils and fecal pellets are common in the finer grained beds (Lambe, 1909,1910; Greiner, 1962). Bioturbation is rare to nonexistent (Pickerill and Carter, 1980; Pickerill, et al., 1985)

The four remaining subenvironments of the Albert Formation contain comparatively few kerogenous beds. The remaining subenvironments are: (1) the interdeltaic, (2) the fluvial-deltaic, (3) the alluvial-fan (piedmont) and (4) the nearshore bar/beach complex.

The interdeltaic subenvironment is composed of fine- to medium-grained sandstones, siltstones, minor shales, argillaceous dolomitic shales and nodular carbonate horizons. The sandstones locally contain pebbles and discontinuous stringers of siltstone and shale. The sandstones are commonly massive and commonly display a scoured base. The sandstone beds are grey to medium grey and, where the sandstones interfinger with kerogen-bearing rocks, may display grey-brown colouration. Plant fragments and evidence of bioturbation are present. Strata assigned to the interdeltaic subenvironment are commonly intercalated with those of the carbonate-flat, marginal open-lacustrine and central open-lacustrine subenvironments (Pickerill and Carter, 1980).

The fluvial-deltaic subenvironment is mainly composed of pebble conglomerates, pebbly sandstones, sandstones, siltstones and shales that are generally deposited in repetitive cycles. The sediments are typically grey but may retain a slight brownish colour where they interfinger with kerogenous beds. The fluvial-deltaic subenvironment is commonly proximal to interdeltaic and alluvial-fan sedimentation but may also be associated with carbonate-flat and marginal open-lacustrine subenvironments (Pickerill and Carter, 1980).

The alluvial-fan subenvironment is mainly composed of conglomerate, with sandstone, siltstone and shale stringers and interbeds. Clasts in the conglomerate are poorly sorted and characteristically subangular. The rocks are commonly grey to buff. Sediments common to the alluvial-fan subenvironment are

intercalated with fluvial-deltaic and marginal open-lacustrine strata. The coarse-grained beds thin and become finer grained toward the centre of the Moncton Subbasin (McCutcheon, 1978). The Caledonia Uplift was the major source of detritus for the alluvial-fan deposits, during deposition of the kerogenous beds.

The nearshore bar/beach complex subenvironment is not present in the Rosevale area. The reader interested in this subenvironment is referred to Pickerill and Carter (1980).

Pickerill and Carter (1980, page 60-61) have interpreted the kerogenous sediments of the Rosevale area to be dominantly marginal open-lacustrine and carbonate-flat sequences. However, they may grade into central open-lacustrine sediments. Rarely, beds of the kerogen-poor fluvial-deltaic and alluvial-fan subenvironments may be interbedded with sediments of the kerogen-rich subenvironments.

V) OIL SHALE ASSESSMENT FOR THE ROSEVALE AREA

The Albert Formation oil shale beds of the Rosevale area have been evaluated and explored for more than 100 years (Bailey, 1864; Bailey and Ells, 1876; Ells, 1909; Wright, 1922; Timm *et al.*, 1948; Worth, 1975, 1977). The most reliable and accurate approach to evaluating the oil shales in Rosevale was undertaken when the Federal Government drilled 36 holes in 1942. Re-evaluation of the Rosevale data between 1982 and 1985 indicated that the eastern part of the Albert Formation exposed

at Rosevale contains oil shale that was inadequately evaluated by previous investigations. The present program was undertaken to re-examine these eastern beds.

A) LOCATION AND ACCESS

The Rosevale assessment area is located approximately 14 km west-southwest of the village of Hillsborough, New Brunswick, along Route 910 (Figure 2). It can be reached easily from Sussex, Moncton, or Hillsborough. The area is sparsely populated and has only a few active farms.

The Rosevale area is drained by primary and secondary tributaries of the East and West Branches of Turtle Creek (Plate 86-161).

B) GEOLOGICAL AND OIL SHALE RESOURCE COMPILATION

Geological and oil shale assessment data were compiled for the Rosevale area and the results of the compilation are shown on Plate 86-161. The data were utilized in selecting the locations of the six drill holes of this project. Fischer Assay results and lithologic logs from the Federal Government drilling program (Timm et al., 1948) were used in the calculation of ore reserves for the Bray Brook Zone.

C) DRILLING

A total of 928 m of NQ core diamond drilling was completed to assess the oil shale beds in the Rosevale area. The contract for drilling was awarded to C.J. Smith (Drilling) Ltd.

of Wallace, Nova Scotia. Drilling commenced September 16, 1985 and was completed October 30, 1985. The core is stored with the New Brunswick Department of Forests, Mines and Energy, Mineral Resources Division, in Fredericton.

The drilling program was designed to outline the strike, subsurface extension and shale oil yield of kerogenous oil shale beds exposed in the Rosevale area. These oil shales were intersected by previous drilling initiated by the Canada Department of Mines and Resources, but had not been adequately defined to permit accurate calculation of oil shale reserves (Timm et al., 1948). Consequently, six diamond-drill holes were spudded, drilled and logged. The results of the drill program indicate that 2 highly kerogenous oil shale zones have been intersected: (1) the Bray Brook Zone and (2) the Baisley Brook Zone (Plates 86-161 and 86-162). The location of the holes drilled during the 1985 Rosevale oil shale assessment are shown on Figure 6. A summary of length, dip, direction, longitude and latitude of each drill hole is shown in Table 2.

Shear zones, possibly associated with the Caledonia Fault, created difficulties during drilling. Three holes were secured for geophysical logging by inserting a continuous length of 3.175 cm (1.25 in.) diameter plastic pipe. This is an adequate measure to prevent slumping or caving in the fractured sections if the geophysical logging equipment is not available upon completion of the drilling. The plastic pipe must be inserted into the drill hole immediately following the drilling.

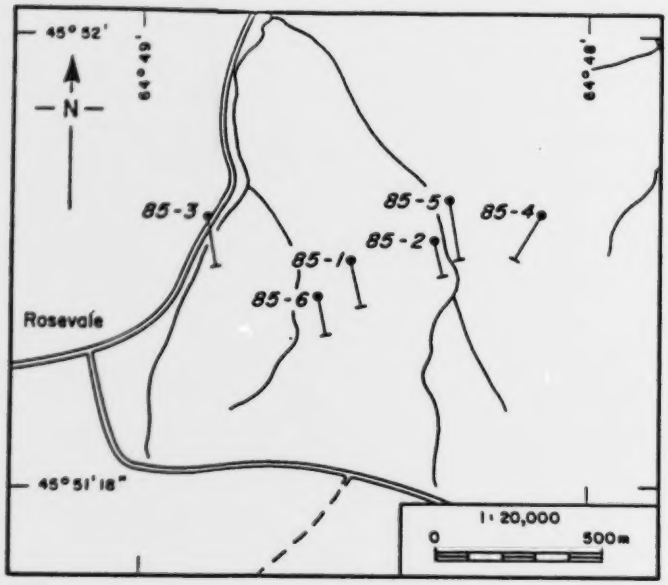


Figure 6 Map showing location of oil shale assessment drill holes

HOLE No.	LENGTH(m)	DIP	AZIMUTH	LAT.	LONG.
RV 1	162.2	60°	170°	45°51'40"	64°48'31"
RV 2	108.0	45°	170°	45°51'41"	64°48'21"
RV 3	151.5	60°	170°	45°51'46"	64°48'52"
RV 3A	20.0	60°	170°	45°51'46"	64°48'52"
RV 4	151.5	60°	210°	45°51'46"	64°48'05"
RV 5	232.2	60°	170°	45°51'47"	64°48'19"
RV 6	102.7	60°	170°	45°51'37"	64°48'37"
TOTAL	928.1				

Table 2 Pertinent data related to diamond - drill holes of the 1985 oil shale assessment

D) LOTHOLOGIC LOGGING

i) Methods

The kerogen contenten in oil shales, and particularly lacustrine oil shales, is commonly highly variable. The quantity of kerogen in oil shale beds is mainly dependent upon the presence of algae, the oxidation/reduction conditions in the environment of deposition, and the influx of coarse detritus. Consequently, the drill core was visually logged in considerable detail to attain a maximium amount of lithologic information. The following criteria were recorded and are compiled on the accompanying lithologic logs (Plates 86-163 to 86-168): (1) angle of bedding to core axis, (2) colour of each rock type, (3) rock type, (4) grain size, (5) relative estimate of kerogen content, (6) relative estimate of carbonate content, (7) sedimentary structures, (8) fossils (fish and plant) and bioturbation features, (9) tectonic features, (10) thickness of beds, and (11) lithologic associations. Appendix A lists the words for which abbreviations have been used on the lithologic logs.

A relative estimate of kerogen content was made using the flame test. Small fragments of oil shale were held in the flame of an alcohol lamp and the ease with which the fragments burn was scored on a scale from 1 to 5. The numerical values and their corresponding burning responses are:

1) Fragment explodes when exposed to alcohol flame, does not ignite

2) Fragment turns black and emits a petroliferous odour when exposed to alcohol flame, does not ignite

3) Fragment ignites in alcohol flame but extinguishes when removed

4) Fragment ignites in alcohol flame and continues to burn with varying degrees of difficulty when removed

5) Fragment ignites in alcohol flame and continues to burn with ease when removed.

The alcohol-lamp flame test is a rudimentary aid in selecting core samples for organic geochemical analysis and also provides a preliminary verification of the geophysical logs. The alcohol lamp flame test results are not included in this report but can be seen on the original drafts of lithologic logs on file with the Department of Forests, Mines and Energy, Mineral Resources Division, in Fredericton.

Hot and cold hydrochloric acid tests were conducted to detect the presence of dolomite or calcite in the core. The tests identified carbonate-rich beds but had limited success in differentiating dolomite from calcite.

ii) Description of Lithotypes

The 928 m of drill core has been divided into five rock types: 1) shale, 2) siltstone, 3) sandstone, 4) intraformational conglomerate and 5) conglomerate. Figure 7 shows the amounts (in metres) of each rock type intersected in each well. The sandstone has been subdivided into five grain-size components related to

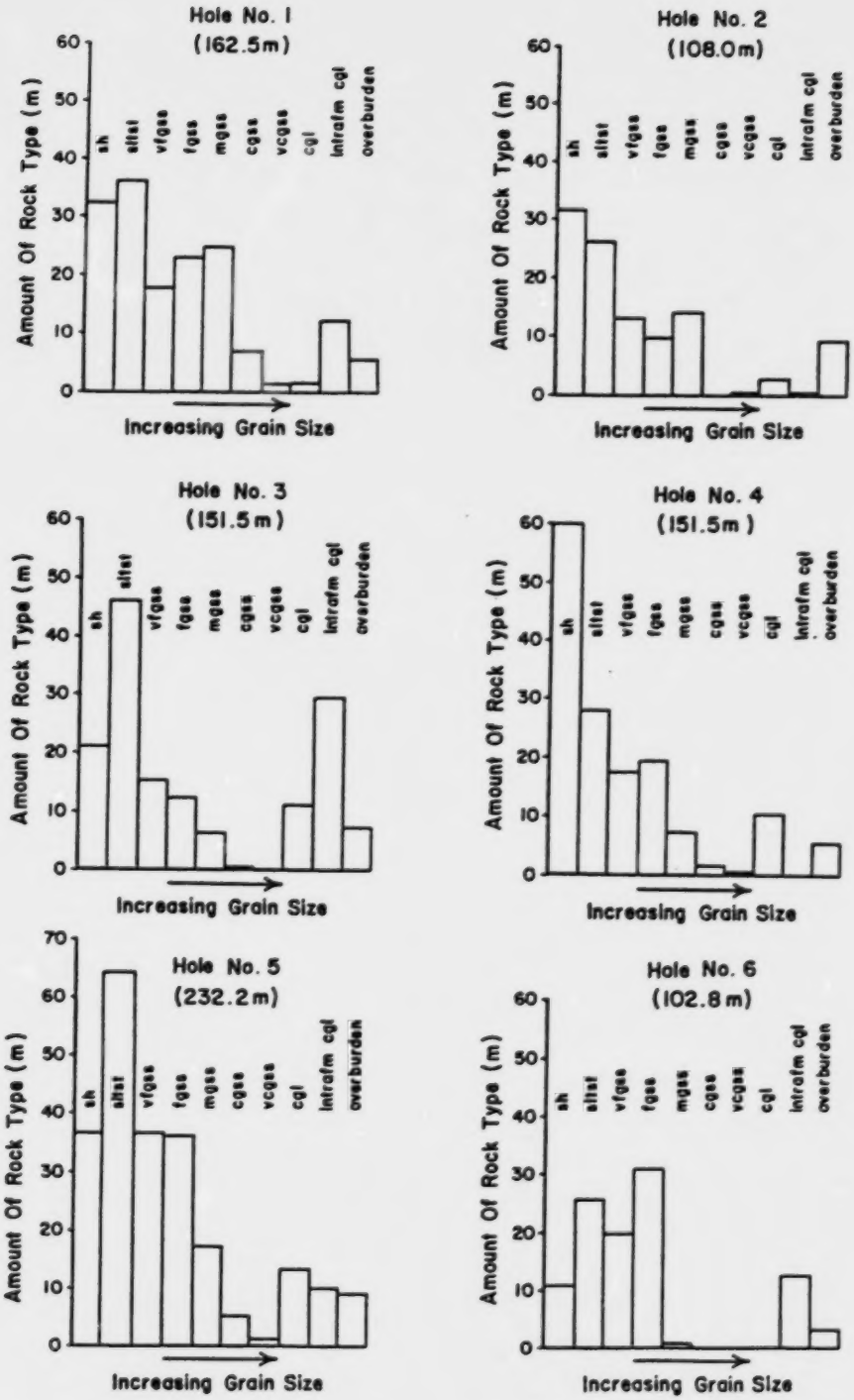


Figure 7 Amount of each rock type in each drill hole. (Abbreviations are listed in Appendix A.)

the detail of the lithologic logging. A detailed description of each rock type is presented below.

SHALE - The shale beds are grey, dark grey, grey brown, yellow brown and dark brown. The carbonate-rich laminae are yellow brown, light brown and brown. The clay-rich laminae are grey and dark grey. The shale beds (Figure 8) commonly have continuous to discontinuous cyclic interlaminations of clay, carbonate and kerogen. The fine carbonate material is mostly calcite, dolomite and rarely iron carbonate. Thin fine-grained sandstone and siltstone stringers are common. Fish scales, fish fossils and fecal pellets occur in the more kerogen rich, brown shale beds, but tend to be absent in kerogen-poor beds. Shales that show bioturbation also tend to be lower in kerogen content. Slump structures, synsedimentary faults, pyrite nodules and carbonate nodules are common. The contact between shale and siltstone is gradational or sharp. The contact between shale and sandstone beds is commonly sharp.

SILTSTONE - Grey, dark grey, grey brown, yellow-brown, brown and dark brown siltstones occur in beds ranging from 1.5 cm to 2 m thick. The beds are commonly laminated and locally display dewatering structures. The dewatering structures mainly occur in beds where sandy stringers are common. The siltstone (Figure 9) comprises yellowish brown carbonate-rich, grey clay-rich and brown kerogen- rich laminations. The kerogen-rich laminae of the siltstone beds are less common and typically thinner than those of the kerogenous shale beds, making the siltstones generally

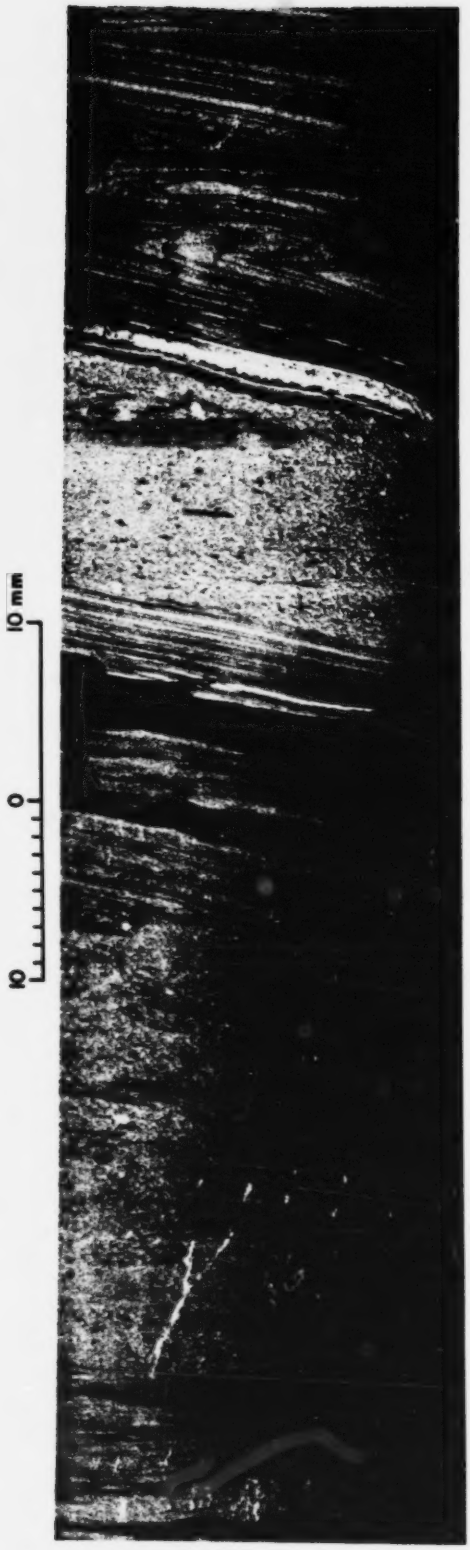


Figure 8

a) Slump folds in laminated kerogenous buff to brown shale.

b) Grey sandy beds with plant fragments.

c) Parallel-laminated kerogenous shale.

d) Sandy stringers with kerogenous shale fragments. (intraformational conglomerate)

(Core from Rosevale No. 5 drill hole, 33.5 m)

less kerogenous than the shales they are interbedded with. Fish fossils, fish scales, fish remains, and minor plant detritus are present. The siltstone beds locally show synsedimentary brecciation, synsedimentary faults, slump structures, sedimentary dykes, pyrite nodules, and bioturbation features. The contact between siltstone and shale beds is generally gradational and the contact between siltstone and sandstone is generally sharp.

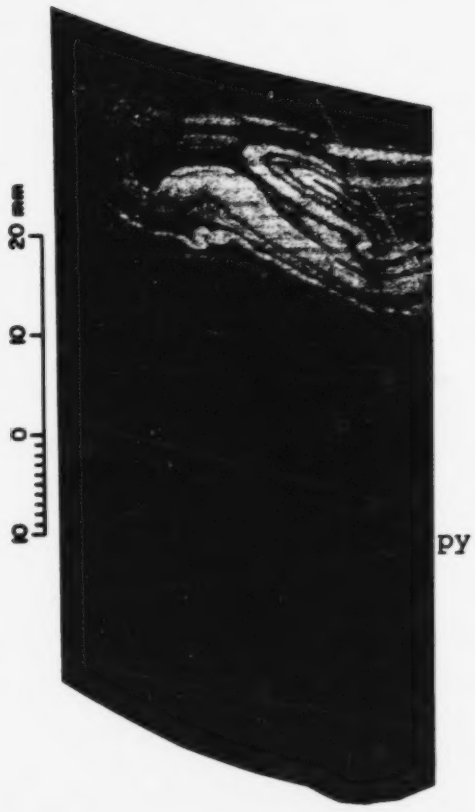


Figure 9 - Slump fold in a thin limestone bed. The limestone is interbedded with brown thickly laminated kerogenous siltstone containing a pyrite band (py) approximately 2 mm thick. (Core from Rosevale No. 3 drill hole, 102 m)

SANDSTONE - The grey, dark grey or buff sandstones are very fine- to medium-grained, with rare coarse- to very coarse-grained beds. The grains are typically well rounded and well sorted. Some sandstone layers are graded, particularly those occuring as stringers in shale and siltstone beds. The sandstone beds can be kerogenous where they grade into kerogen-bearing shale and siltstone beds. The sandstones are commonly fractured and have carbonate veins. Pyrite may be found along fractures, as flecks in carbonate veins or as nodules and bands. Plant detritus and minor plant fragments are present in the coarse beds. Fish scales, minor fish fossils or remains and bioturbation features are found in the very fine- to fine-grained sandstone beds. Good oil stain may be found in porous or fractured sandstone beds. The contacts between sandstones of various grain sizes are generally gradational. The contacts between sandstone and shale or siltstone beds are typically sharp and display scour and fill, rip-up clasts, and flame structures.

INTRAFORMATIONAL CONGLOMERATE - The intraformational conglomerate (Figure 10) contains clasts eroded from beds lying within the Albert Formation. The brown to grey shale and siltstone clasts are supported by grey to dark grey to buff, massive, very fine- to medium-grained sandstone. The intraformational conglomerate contains up to 20% clasts. The beds vary in thickness from approximately 10 cm to 3 m and are believed to represent sandstone slurries or turbidity flows. The fragments are commonly kerogenous. The intraformational conglomerate is commonly intercalated with kerogenous shale, kerogenous silt-

stone, shale, siltstone and sandstone beds. The contact between the intraformational conglomerate and sandstone is commonly gradational. The contact between the intraformational conglomerate and shale and siltstone is sharp and marked by scour and fill, flame structures and rip-up clasts.

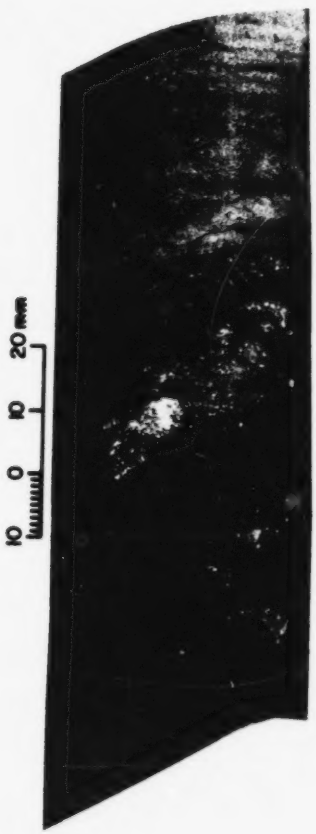


Figure 10 - Kerogenous siltstone fragments in a sandstone bed (intraformational conglomerate) overlying laminated kerogenous siltstone and gritty beds. (Core from Rosevale No. 1 drill hole, 104 m)

CONGLOMERATE - The brown to buff conglomerate contains foliated, angular to subangular clasts of meta volcanic and meta sedimentary rocks that probably originated from the Caledonia Uplift. The conglomerate is commonly supported by a siltstone matrix and the clasts are locally enveloped by live oil stains. The contacts between the conglomerate, siltstone and very fine-grained sandstone are commonly gradational. The conglomerates are believed to have formed as debris flow deposits that were, at least in part, deposited in low-energy environments within the lake.

iii) Sedimentary Structures

The most common sedimentary structure found in the kerogenous shales and siltstones are thin, cyclic, parallel or varved laminations of clay, carbonate and kerogen (Figure 8). The fine grain size indicates a low-energy environment of deposition, and the widespread preservation of organic material indicates a reducing environment.

Slump folds (Figure 8, 11) and synsedimentary faults (Figure 11) are common throughout the shale and siltstone beds but are most commonly found within the kerogenous shales. The slump folds typically have convolute bedding with continuous laminations. Synsedimentary faults generally have offsets of less than 1 cm and can be normal or reverse. The slump structures and synsedimentary faults were probably formed due to slope instability, and were set off by turbidity flows caused by flash flooding or regional fault activity after deposition and prior to

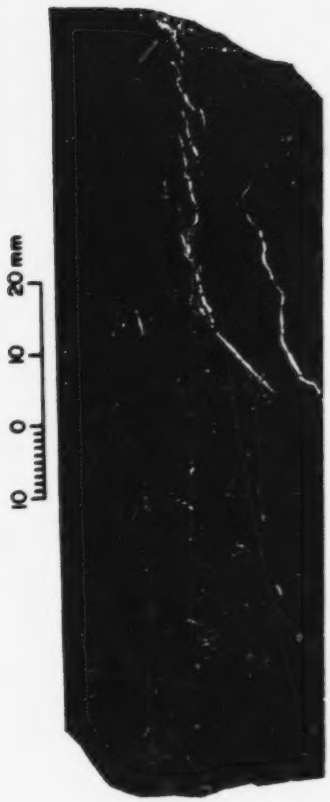


Figure 11 - Complex slump folds in a brown highly kerogenous shale. synsedimentary faults and thin carbonate veins are present.
(Core from Rosevale No. 1 drill hole, 151 m)

consolidation.

Where faults exist close to oil shale occurrences, warping and shearing of the beds occur. In the core, the tectonic folds are difficult to distinguish from slump folds.

Sedimentary (sandstone) dykes or fill structures are

abundant and are commonly found cutting shale and siltstone beds. The contacts between sedimentary dykes and host rocks are sharp and commonly straight, and the sedimentary dykes may contain fragments of the host rock. The sedimentary dykes are believed to form when sandstone layers undergo dewatering and compaction, prior to solidification.

Flame structures and rip-up clasts of shale and siltstone are present at the base of some sandstone beds (Figure 8). The incorporation of clasts of siltstone and shale result from the sudden influx of sandy turbidity flows possibly associated with flash floods.

Sedimentary breccia is most common in dolomitic or calcareous siltstone and very fine-grained sandstone beds (Figure 12). The breccia beds are characterized by randomly packed angular fragments in a silty or shaley matrix. The mechanism by which this feature may have developed is as follows. Siltstone beds from the inshore area of the lake were exposed due to a lowering of the water level. Dessication occurred over a period of time and then the water level was raised again by heavy rain and run off. The corresponding wave action broke up the siltstone bed and formed narrow beds of fragments.

Pyrite occurs in all rock types as nodules, lamina, flecks in quartz-carbonate veins, and pore-space filling in all rock types (Figures 9 and 13).

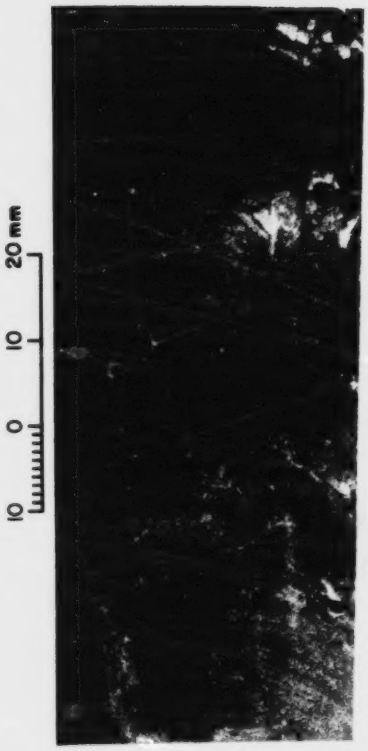


Figure 12

Sedimentary breccia comprising fragments of yellow-brown kerogenous siltstone and minor grey fine-grained sandstone.
(Core from Rosevale No. 5 drill hole, 96 m)

Figure 13

Carbonate nodules (c) in a brown Kerogenous siltstone. The sandy stringer has pyrite nodules (py).
(Core from Rosevale No. 3 drill hole, 102 m)

Carbonate nodules are commonly restricted to the shale beds where they are generally found in clusters (Figure 13). Some of the shale beds intersected in Rosevale No. 3 are good examples of this mode of occurrence.

iv) Fossil data

Core from Rosevale Nos. 1, 2, 4, and 6 yielded four nearly complete fish fossils and numerous scales, fins and other fish remains. Fish fossils (Figure 14) are believed to be from paleoniscid fishes similar to those identified by Greiner (1977) and Lambe (1909). Many examples of scales similar to those sketched by Lambe (1909) were found in the core (see Lithologic Logs). The existence of fish remains in the shale and siltstone beds suggests that the strata represent marginal open- and central open-lacustrine deposits.

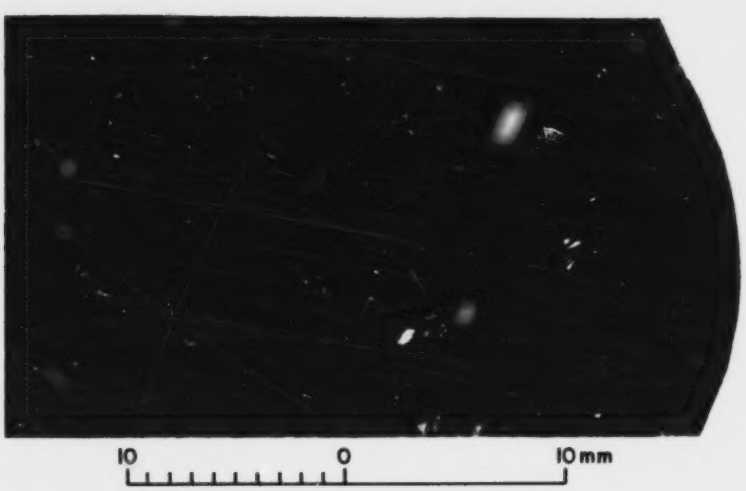


Figure 14 - Fossilized remains of a paleoniscid fish in brown kerogenous siltstone.
(Core from Rosevale No. 1 drill hole, 83 m)

Plant remains are seen in sandstone beds and within sandy stringers (Figure 8) common to the siltstone and shale beds. It is thought that turbidity flows caused by flash flooding rapidly transported and deposited the sand, either at the lake margin or space into the deeper parts of the lake. This rapid transport and deposition preserved the incorporated plant detritus.

The kerogen found in the Albert Formation oil shales is generally believed to have originated from the accumulation and burial of lacustrine algae (Yen and Chilingarian, 1976; Espitalie, et al., 1977). King (1963) distinguished fusiform bodies and possible algal structures in the oil shales of Albert Mines. Additional organic forms have been recorded in the shales in the Albert Mines and Rosevale areas by Kalkreuth and Macauley (1984). Kerogen is present in the carbonate-flat, marginal open- and central open-lacustrine subenvironments (Pickerill and Carter, 1980).

Bioturbation or burrowing features are seen near bedding contacts of siltstone and sandstones. The burrows that occur as unique holes are typically circular, but burrows that occur in clusters may be elongated parallel to the bedding plane. The sedimentary material deposited in the burrows is commonly gritty. Burrows are commonly found in the carbonate-flat subenvironment but may also occur in sediments common to the marginal open-lacustrine subenvironment.

E) GEOPHYSICAL LOGS

Century Geophysical Corporation of Calgary, Alberta carried out geophysical logging on Rosevale Nos. 1, 2, 3, 4, 5, and 6 of the 1985 Rosevale oil shale assessment (Plates 86-169 to 86-174). The logging was undertaken following the completion of the drilling phase of the project but prior to drill demobilization. Three geophysical probe models were utilized for logging the holes, with the choice dependent upon whether the holes were logged in an open hole, through plastic pipe, or through drill rods.

i) Description of Geophysical Logging Tools

The coal probe (Model 9030A) is used to geophysically log unprotected or open drill hloes. This probe records natural gamma, gamma-gamma density, resistivity, and caliper logs with one pass. The natural gamma log provides a measurement of the natural radioactivity of the strata. The apparent density log provides an accurately calibrated density measurement. It typically gives a high response for shale because the radioactive elements tend to concentrate in clay minerals. The resistivity log is produced from a sensor that has a high dynamic range and thereby gives a symmetrical thin-bed response. The caliper log provides a continuous linear measurement of the hole diameter. The caliper arms centralize the probe to achieve the focused density that is required to produce the apparent density log. (Plates 86-169 and 86-171 to 86-174).

The uranium probe (Model 9067) records natural gamma and neutron-neutron logs. The probe is most effective if drill holes must be logged through plastic pipe or drill rods. The coal probe cannot be run under these circumstances and the resistivity log is lost. The neutron-neutron system primarily responds to the presence of hydrogen atoms in water molecules. Consequently, the log records the relative porosity of intersected beds. The neutron-neutron log responses show a close correlation with conglomerate and sandstone beds (Plates 86-169 to 86-174).

The long-spaced density probe (Model 9068) measures natural gamma and relative (gamma-gamma) density. Like the uranium probe, the density probe is most useful if the drill holes must be geophysically logged through drill rods or plastic pipe and the coal probe's apparent density log cannot be generated. For ease of interpretation, the natural logarithm of the relative (gamma-gamma) density data is plotted (Plates 86-169, 86-170, 86-172, 86-173A and 86-173B).

The natural gamma log is the only common output from all three probes. Consequently, in drill holes that are logged by more than one probe, the natural gamma log is used to correlate log responses. Table 3 lists the types of geophysical logs produced from each of the Rosevale holes.

HOLE NO.	LENGTH GEOPHYSICALLY LOGGED (m)	LENGTH DRILLED (m)	COAL PROBE	URANIUM PROBE	LONG-SPACED DENSITY PROBE
RV 1	122.5	162.2			P
RV 1	161.3	162.2	O	O	
RV 2	102.5	108.0		R	R
RV 3	145.1	151.5	O	O	
RV 4	143.9	151.5			R
RV 4	143.7	151.5		R	
RV 4	67.1	151.5	O		
RV 5	150.1	232.2			R
RV 5	150.2	232.2		R	
RV 5	154.8	232.2	O		
RV 6	101.7	102.7	O		
RV 6	101.6	102.7		O	

O, logged in open hole ; P, logged through plastic pipe ; R, logged through drill rods

Table 3 Summary of the geophysical logging intervals and probe types utilized for the Rosevale oil shale assessment

ii) Field Procedures

The drill holes were geophysically logged upon completion of the drilling phase of the project. Upon completion of drilling of the first two holes, shear zones were lithologically logged and it became apparent that plastic pipe would be necessary to prevent collapse and closure of the holes. A continuous length of 3.175 cm (1.25 in.) diameter plastic pipe was inserted in each hole after the drill rods were pulled.

Rosevale Nos. 2, 4 and 5 intersected shear zones (Plates 86-164, 86-166 and 86-167). Rosevale No. 2 was the last hole drilled and was logged through the drill rods because of the extensive fractures lithologically logged from the core. The uranium and long-spaced density probes were used to log Rosevale No. 2 because of their effectiveness in geophysically logging through drill rods. Rosevale No. 4 and 5 collapsed in the shear zones because they had not been supported with plastic pipe. They were reamed before they could be geophysically logged. Rosevale No. 4 collapsed at approximately 70 m, was reamed to its full length and logged through the drill rods with the long-spaced density and uranium probes. Rosevale No. 4 was also logged open above the collapsed zone with the coal probe. Rosevale No. 5 was extensively collapsed and could only be reamed to 155 m. Therefore, the last 80 m of the hole could not be geophysically logged. Rosevale No. 5 was logged through the drill rods using the uranium and long-spaced density probes. After pulling the drill rods, the hole remained open and a pass with the coal probe

was achieved.

Rosevale Nos. 1 and 6 intersected shear zones and plastic pipe was inserted to prevent collapse of the holes. During the geophysical logging procedure, it was discovered that the plastic pipe could be removed. Upon removal, the coal probe was utilized to collect additional data. Drill holes 1 and 6 were logged in this way with the coal and uranium probes.

Rosevale No. 3 was stable and did not require plastic pipe or drill rods to prevent collapse. This permitted logging of hole 3 with the coal and uranium probes.

iii) Methods of Interpretation

The geophysical data from each hole (Rosevale No. 1 through 6) are compiled and presented on Plates 86-169 to 86-174. A simplified lithological log is presented on the left side of the geophyical logs for ease in correlation and interpretation of the data. A description of the different logs produced and their relative merits are given below.

The natural gamma log, which is recorded by all three probes, appears to show little correlation with the sedimentary facies of the Albert Formation, including the kerogen-rich beds can be seen by examining the organic geochemical logs on plates 86-175 to 86-180. The primary use of the natural gamma log in differentiating lithologic groupings can be seen on the geophysical log for Rosevale No. 3 (Plate 86-171) where the Hillsborough Member of the Moncton Formation unconformably

overlies the Albert Formation. The Hillsborough and Albert rocks are readily distinguishable by their natural gamma log signatures.

The resistivity log records the resistivity of rock located between two sensors of the coal probe that are 1 m apart. The data are recorded on a logarithmic scale with values ranging from 1 to 10,000. The resistivity log shows a generally positive relationship between a decrease in grain size and an increase in resistivity. This is particularly true of siltstone and shale. The amount of kerogen in the beds does not appear to significantly affect the resistivity. This factor makes the resistivity log a valuable aid in detecting and tracing kerogen-poor shale and siltstone beds when constructing sections. The resistivity and apparent density log responses, when used in conjunction with each other, are utilized to distinguish kerogen-rich shale and siltstone beds.

The neutron-neutron log recorded by the uranium probe provides a measure of the relative porosity. Positive responses found on this log are closely related to sandstone and conglomerate beds of the associated lithological log. Four sandstone beds found in association with the Bray Brook Zone oil shales have been outlined because of their characteristic neutron-neutron log responses and were used as marker beds for construction of cross sections E-F, G-H, I-J and K-L (Plates 86-183, 86-184, 86-185 and 86-186, respectively) and longitudinal section A´-B´ (Plate 86-187).

The apparent density log recorded by the coal probe and the relative (gamma-gamma) density log recorded by the long-spaced density probe are very useful for a geophysical analysis of oil shale sequences. Both logs show a decrease in density with an increase of organic carbon or kerogen content in the oil shale beds. This relationship can be seen by comparing the density log found on the geophysical logs with the organic carbon or hydrocarbon potential logs found on the geochemical logs.

The apparent density log appears to be the better of the two density logs. This log is computer generated from the simultaneously run gamma-gamma density and caliper logs. In this way, the apparent density log is compensated for mass deficiencies resulting from caves or other irregularities in the drill-hole wall. The density logs have aided greatly in tracing the oil shale through the Bray Brook Zone (Plate 86-162).

The Rosevale No. 3 apparent density data shows spurious results, which indicate a thick kerogen-rich intersection. This was not indicated by flame tests conducted during lithologic logging of the core. The resistivity and rock type columns of Plate 86-171 clearly show the absence of highly kerogenous shale or siltstone between 84 and 108 m - the intersection in question. The information provided on the apparent density log for Rosevale No. 3 shows the need for confirmation of the apparent density results by the use of relative density data, organic geochemistry or alcohol-lamp flame tests of the core from the encouraging intersections.

F) CORE GEOCHEMISTRY

To determine the oil shale reserves of the Rosevale assessment area, 505 samples, for a total length of 356.5 m, of the drill core were collected and tested by Rock-Eval pyrolysis, total organic carbon and total carbon methods. The sampling techniques, methods of geochemical analysis, data conversion and interpretation are described below.

i) Sampling Methods

Five hundred and five intervals of core were cut longitudinally by rock saw. Approximately one-third of the core was packaged and shipped for analysis; the remaining two-thirds was retained. The rock saw method of cutting the core for sampling was employed to preserve the maximum amount of core for future study, either analytically or lithologically. The samples were cut in 0.6 m intervals from the kerogen-bearing beds within the Bray Brook Zone. Samples collected from kerogenous beds outside the Bray Brook Zone were generally 1 m in length to permit greater coverage. Where the core was fractured and could not feasibly be sawed, approximately one-third of the core, which formed a representative sample, was collected by hand.

The samples were shipped to Core Laboratories Incorporated of Dallas, Texas for Rock-Eval pyrolysis, total organic carbon analysis and total carbon analysis.

ii) Organic Geochemical Parameters

Espitalie, et al. (1977) divided kerogen into three main types (TYPE I, TYPE II and TYPE III). Macauley and Ball (1982) and many others have assigned the following organic source and environments of deposition to the three kerogen types:

TYPE I - Algal deposits formed in lacustrine environments.

TYPE II - Algal deposits formed in marine environments.

TYPE III - Mainly humic plant debris deposited in either marine or continental environments.

The three types of kerogen can be distinguished by plotting their atomic hydrogen/carbon and oxygen/carbon ratios (Tissot, et al., 1974). It has also been determined (Espitalie et al., 1977) that the three kerogen types can be distinguished by plotting hydrogen index and oxygen index results generated from the Rock-Eval pyrolysis and total organic carbon analysis.

The Rock-Eval pyrolysis analyzer yielded the following organic geochemical parameters from the samples of Albert oil shale beds:

(1) S1; the amount of free hydrocarbons, in mg/g of rock sample,

(2) S2; the amount of hydrocarbons generated by pyrolysis of organic matter, in mg/g of rock sample,

(3) S3; the amount of organic CO2 generated by pyrolysis of organic matter, in mg/g of rock sample,

(4) Tmax; the temperature, in degrees Celsius, at which maximum generation of hydrocarbons occurs.

The core samples were also subjected to total organic carbon analysis. This analysis detects the amount of organic carbon present in the core samples, in weight percent. (Appendix B lists results of geochemical analysis.)

The Rock-Eval pyrolysis and total organic carbon (TOC) data are utilized to generate the following 'genetic' criteria by employing the related formula (Appendix B lists results of calculated geochemical parameters.):

Hydrogen Index = (S2/TOC) x 100

Oxygen Index = (S3/TOC) x 100

Oil and Gas Potential = S1 + S2

Transformation Ratio = S1/(S1 + S2)

Where the hydrogen index and oxygen index results are plotted for rock samples from a wide range of depositional environments, it is seen that the samples fall into three roughly distinct fields that correspond with the three types of kerogen designated by Espitalie et al. (1977). The three standard kerogen-type curves are shown as background for the hydrogen and oxygen index values plotted on Figure 15. The three curves are aid in the interpretation of the origin and character of the oil shales that comprise the Bray Brook and Baisley Brook Zones. The hydrogen and oxygen index values are derived from organic geo-

chemical analysis of Rosevale core samples recovered during the 1985 oil shale assessment. Figure 15 shows that 87% of the samples lie near the TYPE I kerogen curve, which supports a lacustrine origin of algal organic matter. The remaining samples, mostly from coarser beds, are believed to represent a combination of Type I and Type III kerogens. Observations of plant detritus in sandy stringers within the shale and sandstone beds lend credence to this assumption.

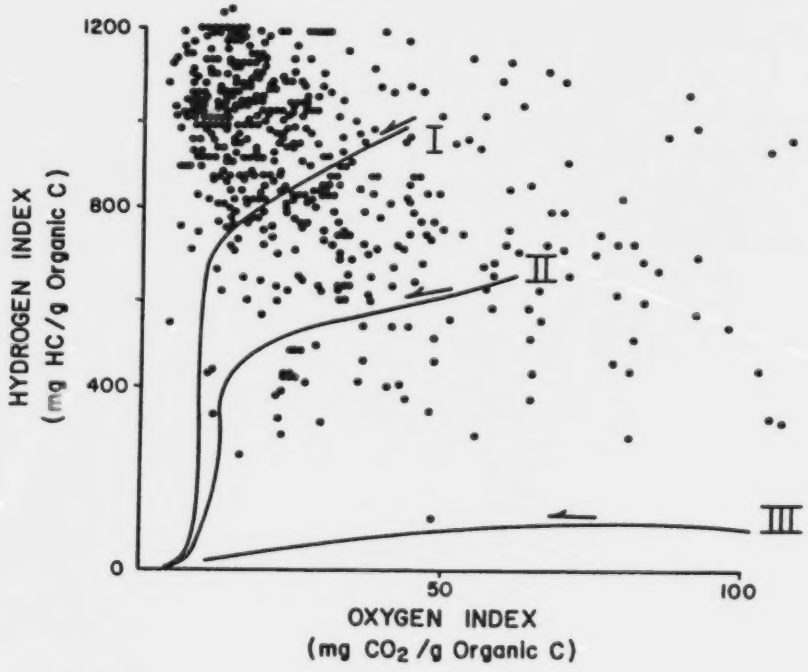


Figure 15 Hydrogen index vs. oxygen index, organic geochemical results from Rosevale oil shale assessment

Another factor which affects the quality and shale oil yield is the quantity of hydrogen preserved within the kerogen (Macauley, 1981). If there is sufficient hydrogen, a better quality shale oil is produced during pyrolysis. The hydrogen content in the Rosevale oil shales is high as shown by the hydrogen index values (Appendix B and Figures 15 and 16). Figure 16 shows the relationship between oil and gas potential and hydrogen index (mg HC/g organic carbon). The curve shown on Figure 16 indicates a rapid increase in hydrocarbon (HC) yield with hydrogen index values greater than 880 mg HC/g of organic carbon and oil and gas potential values greater than 50 mg HC/g of rock. Of the 505 samples collected during the 1985 oil shale assessment, 56% have hydrogen index values above 880 mg/g and 42% have oil and gas potential values greater than 50 mg/g.

High hydrogen index indicates minimal hydrogen depletion and thereby demonstrates the relative immaturity of the Albert oil shales at Rosevale. The natural process of oil and gas generation, brought about by increasing temperatures or prolonged burial has not occurred. The average transformation ratio of 0.09 is also a strong indicator of the immaturity of the Rosevale shales.

iii) Mineral Carbon Geochemistry

The amount of carbonate is important if the oil shale is to be used as a sorbent. Greater than 7% calcium is generally required for the oil shale to act as an effective scrubbing agent in coal-burning thermal generating stations. The percent of

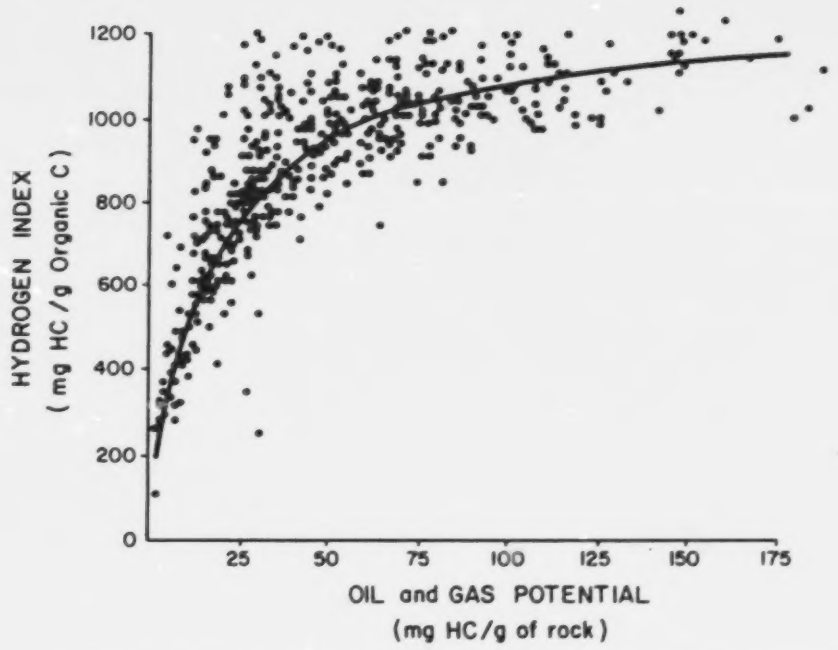


Figure 16 Hydrogen index vs. oil and gas potential, organic geochemical results from Rosevale oil shale assessment

carbonate-carbon is calculated by subtracting the total organic carbon value from the total carbon value (Appendix B). The organic geochemical logs show a histogram plot of carbonate-carbon results (Plates 86-175 to 86-180). To determine the weight percent of each carbonate mineral present in the rock, the ratios of the various carbonate minerals must be known. Macauley and Ball (1982) reported x-ray diffraction results that indicate dolomite as the dominant carbonate mineral in the oil shale beds of the Rosevale area. For the purposes of this report, it is assumed that dolomite comprises 100% of the carbonate mineral.

To determine the amount of dolomite, a ratio to convert carbonate carbon values to dolomite weight percent is required. The ratio is calculated by dividing the molecular weight of dolomite by the atomic weight of carbon.

$$\text{Ratio} = \frac{1/2Ca + 1/2Mg + C + (O*3)}{C}$$

$$= \frac{(40)/2 + (24)/2 + 12 + (16*3)}{12}$$

$$= 7.67$$

Based on the assumptions made for the carbonate mineral content of the Bray Brook Zone, the factor for converting the carbonate carbon data to percent of dolomite is 7.67.

iv) Interpretation

The organic geochemical logs for Rosevale Nos. 1 through 6 (Plates 86-175 to 86-180) show curves or histograms for the following parameters: (1) total organic carbon (wt. %), (2) Tmax (degrees C), (3) hydrogen index (mg HC/g organic carbon), (4) oxygen index (mg CO2/g organic carbon), (5) oil and gas potential (S1 + S2, mg HC/g rock), (6) transformation ratio (S1/(S1 + S2)) and (7) carbonate carbon (wt. %). A simplified lithologic column is shown on the left side of the organic geochemical logs to assist with correlation and interpretation of the data.

The organic geochemical logs are used to evaluate the potential of the Rosevale oil shales. The potential is assessed by analyzing the following data sets:

1) The hydrogen index, oil and gas potential and total organic carbon values show a sympathetic relationship. All three indicies increase with an increase in kerogen content. The quantity of kerogen is visually estimated from the physical characteristics of the beds, such as lamination development, and the Alcohol-lamp flame test described above.

2) An increase in the oxygen index and transformation ratio values correspond to a relative decrease in kerogen content.

Kerogen content is largely controlled by grain size. Correlation of the oil and gas potential histogram and the lithologic column indicates that shale, siltstone and very fine- to fine-grained sandstone beds contain bitumen and/or kerogen. The data indicates that an increase in oil and gas potential corresponds to a decrease in the grain size of the beds.

The carbonate carbon data for the Rosevale oil shale beds can be converted to weight percent of carbonate minerals if the relative amounts of those minerals are known or assumed. Fluctuations in carbonate carbon values for the Rosevale area do not appear to have a strong correlation with the amount of kerogen content.

The oil and gas potential histograms of Rosevale No. 1, 2, 4 and 6 outline organic-rich beds (Plates 86-175, 86-176, 86-178, and 86-180). The drill core intersections of these beds, designated the Bray Brook Zone, have an average oil and gas

potential of 79.8, 90.6, 109.7 and 83.8 mg/g hydrocarbons. The zone has an approximate average yield of 100 l/t shale oil, an average width of 15 m, and a surface strike length of approximately 900 m. A number of other lower grade oil shale beds underlie and overlie the Bray Brook Zone.

The Baisley Brook Zone is not well outlined but favourable organic geochemical responses attributed to this zone can be found on logs from Rosevale No. 3 and 5 (see Plate 86-177 and 86-179).

The remaining geochemical data, which were recorded during testing of the core samples, but not plotted on the logs, can be found in Appendix B.

v) Conversion of Oil and Gas Potential and Total Organic Carbon Values to Shale Oil Yield

There are two methods to convert organic geochemical data shale oil yield (l/t), as described by Macauley and Ball (1982). In the first method of conversion, the oil and gas potential data (calculated from Rock-Eval pyrolysis data) is divided by the specific gravity of the shale oil generated from the kerogen bearing rocks (i.e., (S1+S2)/sp. gr.). Test results from samples collected at Rosevale during the 1942 drilling program indicate an average specific gravity of 0.884 for the shale oil. The results of the specific gravity conversion are recorded in Appendix C.

The second method of conversion relies on establishing

a ratio for the amount (l) of shale oil for each percent of organic carbon. The ratio for conversion of the total organic carbon data to shale oil yield (l/t) was developed and reported by Macauley and Ball (1982). They analyzed 129 samples and found the average shale oil yield to be 8.67 l/t for each percent of organic carbon. They also found that lithologic zones outlined in the Albert Mines oil shale deposit have varying shale oil yields with respect to total organic carbon content. They presented limited information related to the oil shales of the Rosevale area. However, using data from Albert Mines, a rate of 9 l/t for each percent of organic carbon was chosen for the conversion calculation. The results for this conversion are recorded in Appendix C.

A comparison of the two methods of conversion are shown by the plot in Figure 17. The conversion using shale oil specific gravity gives results that are 130% higher than the results determined using the total organic carbon conversion. In the high-grade beds, such as those in the Bray Brook Zone, the difference averages 139.5%. The variance in these results indicates further study is needed to determine the more reliable method of conversion.

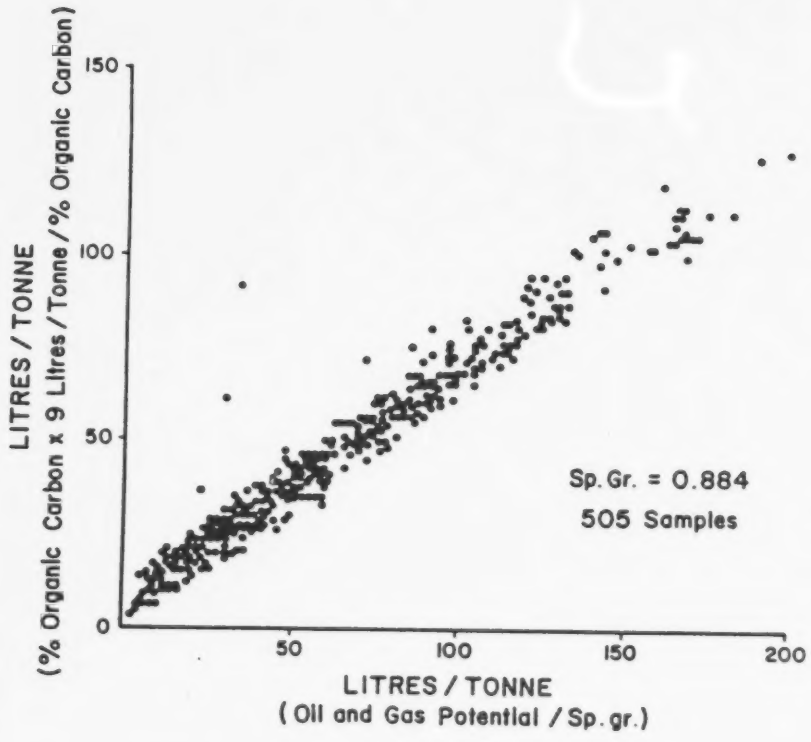


Figure 17 Shale oil yields calculated from total organic carbon and oil and gas potential, organic geochemical results

VI) DATA INTERPRETATION

The 1942 drilling program intersected relatively high yielding oil shales in the Rosevale area (Timm et al., 1948). The 1985 drilling project (described in this report) has provided the data necessary to calculate oil shale reserves and to define the geological setting of the oil shale strata at Rosevale. The results from this project, supplemented by the compilation of historical exploration data, indicate the existence of two kerogen-rich shale and siltstone sequences named the Bray Brook Zone and the Baisley Brook Zone (Plate 86-161 and 86-162).

The Bray Brook Zone was intersected in four wells (Rosevale No. 1, 2, 4, and 6) and sufficient thicknesses of highly kerogenous beds were found to warrant calculation of oil shale reserves (t), average potential yield (l/t) and average carbonate mineral content (wt. %). The reserves were calculated using cross and longitudinal sections, and geochemical and geophysical data. Detailed descriptions of the methods and data employed in the oil shale reserve calculations are presented below.

The Baisley Brook Zone was not defined in sufficient detail to warrant oil shale reserve calculations, but pertinent data are presented.

A) BRAY BROOK ZONE

i) Cross and Longitudinal Sections

Six cross sections (Plates 86-181 to 86-186) and one longitudinal section, (Plate 86-187) at a scale of 1:1,000, were constructed using the detailed lithologic logs. The scale of the sections prohibits accurately displaying thinner beds. Therefore, the most abundant rock type in a sequence of beds is utilized to define the facies outlined on the sections. The "interbedded facies" presented on the sections and on the detailed geological map of the Rosevale area (Plate 86-162) represent sandstone, siltstone, shale and minor conglomerate, with beds too thin to be differentiated.

Lithologic logging of Rosevale Nos. 1, 2, 4 and 6 indicated that all four drill holes intersected the Bray Brook Zone. The lithologic logs were correlated with their respective geophysical (Plates 86-169, 86-170, 86-172 and 86-174) and geochemical logs (Plates 86-175, 86-176, 86-178 and 86-180) in an attempt to trace lithologic units between holes (Cross Sections E-F, G-H, I-J and K-L; Plates 86-183 to 86-186,). The highly kerogenous beds, identified by organic geochemical responses, and relative density and apparent density geophysical responses, are easily identified and correlated, and are outlined by a vertical-lined pattern on the sections and on the detailed geological map (Plate 86-162)

The highly kerogenous shale and siltstone beds of the

Bray Brook Zone are intercalated with sandstone beds. The neutron-neutron (porosity) log has a characteristic response over four sandstone beds (labeled A, B, C and D). The four sandstone beds can be identified in all drill holes intersecting the Bray Brook Zone The relationship of the sandstone beds to the kerogenous shales and siltstones of the Bray Brook Zone can be seen on the geophysical logs (Plates 86-169, 86-170, 86-172, 86-174), sections (Plates 86-183 to 86-187), and on the detailed geological map (Plate 86-162). Sandstone beds A, B, C and D provide the correlation necessary to accurately construct the longitudinal section A´-B´ (Plate 86-187).

ii) Grain-size Distribution

The grain size of the strata is very important. Thick beds of coarse or hard sediments, if interbedded with the highly kerogenous beds, could add difficulty to mining, crushing, and ore beneficiation. Figure 11 shows the percentage composition of each rock type found in the intersections of the Bray Brook Zone. This figure demonstrates the dominance of shale and siltstone. The amount of shale, siltstone and very fine-grained sandstone ranges from 70.8% in the east, to 86.6% in the centre and to 61.7% in the western part of the zone.

iii) Oil Shale and Carbonate Reserve Calculation

The extent of the Bray Brook Zone became apparent during the drilling phase of the program; completion of the sections provided the information necessary to calculate the

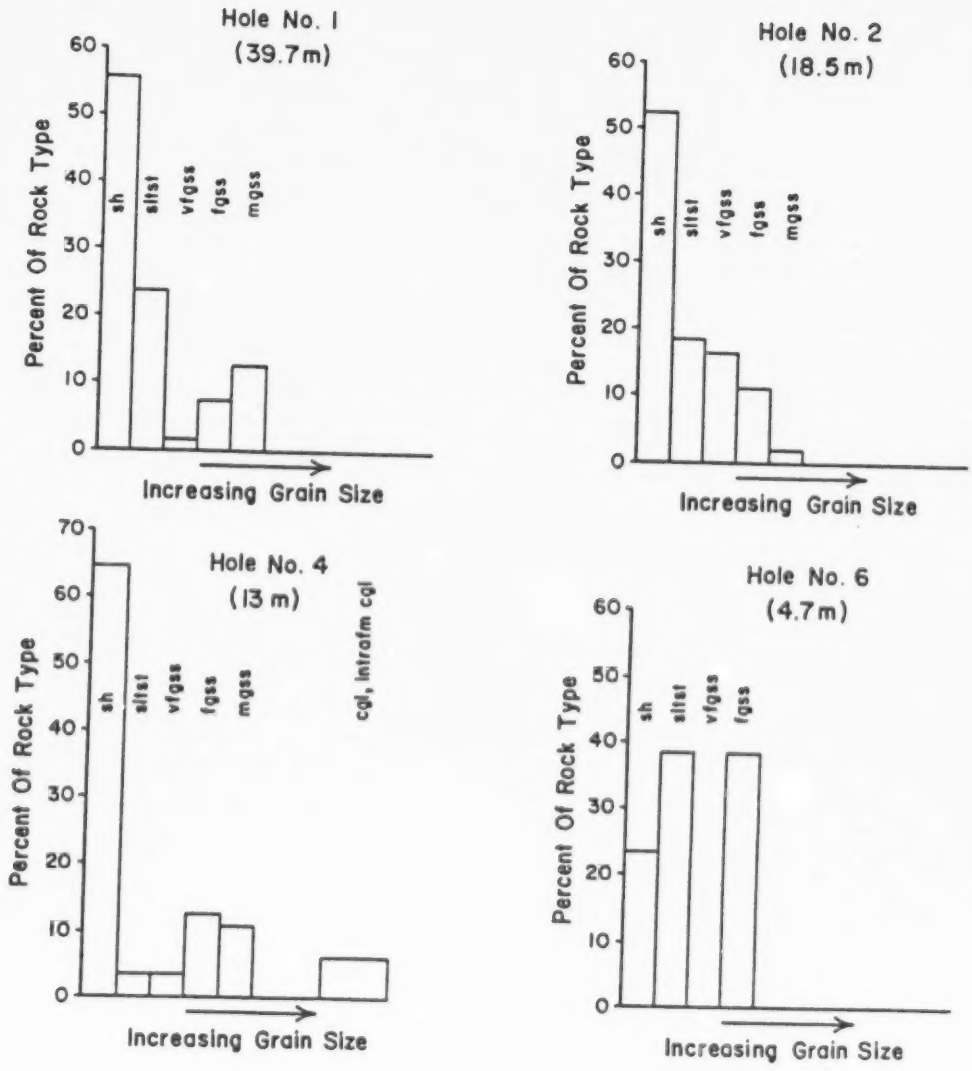


Figure 18 Rock types present in each intersection of the Bray Brook Zone

volume of rock in the kerogenous sequence. An oil shale reserve zone was blocked out and is outlined on the cross sections E-F, G-H, I-J and K-L and longitudinal section A´-B´.

The intersections and average grades for the oil shales of the Bray Brook Zone are listed in Table 4.

HOLE No.	INTERVAL(m)	LENGTH (m)	AVERAGE GRADE (litres / tonne)
85-1	117.4 - 155.2	38.7	90.3
85-2	56.0 - 74.6	18.6	102.5
85-4	47.0 - 74.6	27.6	124.1
85-6	68.8 - 72.2	3.4	94.8

Table 4 Oil shale intersections of the Bray Brook Zone

A preliminary standard mine calculation was undertaken using the following assumptions:

1) The open pit mining depth is taken at 100 m below ground level from each cross section.

2) The beds have a consistent dip of approximately 45 degrees.

3) The stripping ratio is not taken into account.

4) The kerogenous beds overlying the Bray Brook Zone are not recovered during stripping. The most notable bed is a 4.8 m intersection of 83.4 l/t from 39.6 to 44.4 m in Rosevale No. 2 on cross section I-J (Plate 86-185). This lense could possibly be, at least in part, recovered.

5) All the highly kerogenous shales 'blocked out' for oil shale reserve calculation would be recovered including the lower grade beds.

6) A minimum aggregate yield of 100 l/t is taken.

7) The specific gravity of the oil shale is assumed to be 2.2.

8) There is no dilution.

There are three steps employed in calculating oil shale reserves for the Bray Brook Zone as outlined on cross sections E-F, G-H, I-J and K-L and longitudinal section A'-B' (Plates 86-183 to 86-187). The steps are: 1) calculation of the total volume of the blocked out areas on the sections, 2) calculation of the average shale oil yield of the blocked out section, 3) calculation of the total weight (t) of oil shale in the blocked out section.

The volume of the outlined beds of the Bray Brook Zone is calculated by first determining the area of the blocked out kerogenous beds shown on the four cross sections. Next, the third

shale reserves of the Rosevale area can be substantially increased. The oil shale reserves reported here are preliminary and further drilling, geochemical analyses, geophysical logging and an in-depth feasibility study are minimum requirements prior to possible development.

B BAISLEY BROOK ZONE

Limited drill intersections on the Baisley Brook Zone precluded accurate oil shale reserve calculations. Insufficient oil shale volume in the eastern section of the zone is indicated by narrow intersections in Rosevale No. 3 and No. 5 (Cross Sections A-B, C-D, G-H and I-J; Plates 86-181, 86-182, 86-184 and 86-185) and holes 42-28 and 42-34 of the 1942 drilling program (Timm et al., 1948). The zone apparently strikes beneath the unconformably overlying Hillsborough Member of the Moncton Formation and is worthy of testing to the west. Historical data shown by Wright (1922), although not conclusive, indicates the Baisley Brook Zone may thicken to the west. Average shale oil yields for the four drill intersections of the Baisley Brook Zone are shown in Table 5.

HOLE No.	INTERVAL(m)	LENGTH (m)	AVERAGE GRADE (litres / tonne)
85-3	132 – 137	5.0	89.6
85-5	58 – 70	12.0	68.9
42-28	100 – 106	6.0	72.0
42-34	43.1 – 45.7	2.6	68.1

Table 5 Oil shale intersections of the Baisley Brook Zone

VII) CONCLUSIONS

The 1985 Rosevale oil shale assessment provides a set of criteria which will aid in future evaluation of oil shale deposits lying in the Hillsborough Zone of Moncton Subbasin. These criteria are:

1) The sedimentary environment of the Albert Formation in the Hillsborough Zone of the Moncton Subbasin is lacustrine. This is based on interpretations of geochemical and geological data as presented in this report. The hydrogen index vs. oxygen index plot of organic geochemical data collected during this program supports this interpretation.

2) The subenvironments common to the Rosevale area are dominantly carbonate-flat, marginal open- and central open-lacustrine (Pickerill and Carter, 1980; Worth, 1977; Greiner,

1962).

3) The oil shales found in the Rosevale area of the Hillsborough Zone contain abundant hydrogen and will thus yield a quality shale oil. Abundant hydrogen is indicated by the large hydrogen index values calculated from the Rock-Eval pyrolysis and total organic carbon results.

4) The oil and gas ootential results (calculated from the Rock-Eval pyrolysis data) divided by the specific gravity of the shale oil is used to provide the average shale oil yield of the samples.

5) The immaturity of the Hillsborough Zone oil shales is indicated by the transformation ratios, thus, these oil shales have the potential for high hydrocarbon yields. The shales may average 100 l/t shale oil from the kerogenous beds of the Bray Brook Zone.

6) Dolomite appears to be the dominant carbonate mineral present in the oil shales.

7) The dolomite (or dolomite equivalent) content of the Bray Brook Zone is approximately 27%. Carbonate carbon averages 3.5% over the zone.

8) The preliminary oil shale reserve calculations indicate that the Bray Brook Zone, to a depth of 100 m, contains 4,400,000 t of oil shale yielding approximately 100 l/t shale oil. The zone has a surface strike length of 900 m and an average

thickness of approximately 15 m.

The oil shale reserves can be increased substantially if the cutoff shale oil yield of 100 l/t is lowered, or if the Bray Brook Zone and Baisley Brook Zone can be extended.

9) For future projects, apparent density (if possible), resistivity (if possible), relative (gamma-gamma) density, neutron-neutron (porosity), and natural gamma logs should be provided for each hole to allow accurate lithologic correlation between holes.

10) The resistivity log is necessary to correlate kerogen-poor shale and siltstone beds between holes.

11) The neutron-neutron (porosity) log is necessary to correlate sandstone beds between holes.

12) The apparent density and relative density logs are necessary to correlate kerogen-rich beds between holes. When combined with alcohol-lamp flame test results, the logs can be used to outline lengths of core to be samples for organic geochemical analysis.

13) Oil shale reserve calculations were not conducted on the Baisley Brook Zone because of the lack of detailed drill intersections. There appears to be promise for the zone west of the present project area. The kerogenous beds in this zone are believed to have been deposited in marginal open-lacustrine and carbonate-flat subenvironments.

VIII) RECOMMENDATIONS

Preliminary recommendations are to complete Rock-Eval pyrolysis testing on the following lengths of core:

1) Hole 85-1 10 to 25 m
2) Hole 85-2 10 to 14 m
3) Hole 85-3 111 to 130 m
4) Hole 85-4 76 to 82 m
5) Hole 85-5 144 to 160 m

This is a total of 60 m and should be tested in sample lengths of 1 m.

If the cutoff grade were lowered to 60 l/t shale oil the following lengths of core should be tested:

1) Hole 85-5 9 to 16 m
2) Hole 85-5 12 to 19 m

These two sections (14 m) are within the Baisley Brook Zone.

To develop a conversion factor for use with the "l/t shale oil for each percent of organic carbon" method of converting percent organic carbon data to litres per tonne, approximately 10 samples from each intersection of the Bray Brook Zone should be tested by Fischer Assay. These results would allow the computation of a more accurate conversion value for the oil shales at Rosevale.

The Baisley tunnel shown on Plates 86-161 and 86-162 may indicate a high-yield extension to the Bray Brook Zone. Two drill holes should be located along strike between the Baisley tunnel and Rosevale No. 6 to test this possibility.

The Baisley Brook Zone should be tested by drilling west of the present project area to determine if kerogenous shales are present in that part of the zone.

A feasibility study should be undertaken to determine the economics of the Bray Brook Zone.

With the information gained from this project it should be possible to evaluate other potential oil shale deposits of the Moncton Subbasin.

IX) ACKNOWLEDGEMENTS

The authors wish to express their appreciation to C. St. Peter for his able help and direction given during this project, specifically the availability of references and personal notes, direction in lithologic logging, and termination of drilling at the well site. Thanks are also put forward to C. St. Peter and B. Carroll for the hours of dedicated editing of this report. The authors also wish to express their thanks to M. Lindsay for his professional drafting of the logs, maps and figures.

REFERENCES

BAILEY, L.W., 1864. Report on the mines and minerals of New Brunswick. Legislative Assembly, Fredericton, New Brunswick, Appendix 7, 73 p.

BAILEY, L.W., and ELLS, R.W., 1878. Report on the Lower Carboniferous belt of Albert and Westmorland Counties, New Brunswick, including the "Albert Shales". Geological Survey of Canada, Report of Progress 1876-77, pt. XII, p. 356-371. Accompanying Map, 1876.

BELT, E.S., 1968. Post-Acadian rifts and related facies, eastern Canada. In Studies of Appalachian geology, northern and maritime. Edited by E. An Zen, W.S. White. J.B. Hadley and J.B. Thompson Jr. Interscience, Toronto, pp. 95-113.

CARTER, D.C., and SHAW, R., 1979. Albert Formation compilation. Department of Natural Resources, Mineral Resources Branch, Fredericton. Open File Report 79-33.

ELLS, R.W., 1909. Bituminous shales of Nova Scotia and New Brunswick: with notes on the geology of the oil-shales of Scotland. Geological Survey of Canada, Summary Report, 1908, p. 132-142.

ESPITALIE, J., MADEC, M., TISSOT, B., MENNING, J.J. and LEPLAT, P. 1977. Source rock characterization method for petroleum exploration. Proceedings 9th Annual Offshore Technology Conference, Houston, Texas, pp. 439-444.

GREINER, H.R., 1962. Facies and sedimentary environments of Albert shale, New Brunswick. Bulletin of the American Association of Petroleum Geologists, Vol. 46, pp. 219-234.

GREINER, H.R., 1977. Crossopterygian fauna from the Albert Formation, New Brunswick, Canada, and its stratigraphic-paleoecologic significance. Journal of Paleontology, Vol. 51, pp. 44-56.

GUSSOW, W.C., 1953. Carboniferous stratigraphy and structural geology of New Brunswick, Canada. Bulletin of the American Association of Petroleum Geologists, Vol. 37, pp. 1713-1816.

HACQUEBARD, P.A., 1972. The Carboniferous of eastern Canada. In 7th Congress International de Stratigraphie et de Geologie du Carbonifere, Krefeld, Comptes Rendus 1, pp. 69-90.

HOWIE, R.D., 1965. Structures and stratigraphy of the Stoney Creek oil field, New Brunswick. Geological Survey of Canada, Report of Activities, Pt. 2, Paper 65-2, Item 39, P. 71.

HOWIE, R.D., and BARSS, M.S., 1975. Upper Paleozoic rocks of the Atlantic Provinces, Gulf of St. Lawrence, and adjacent continental shelf. In Offshore geology of eastern Canada. Edited by W.J.M. van der Linden and J.A. Wade, Geological Survey of Canada. Paper 76-30, pp. 35-50.

KALKREUTH, W. and MACAULEY, G., 1984. Organic petrology of selected oil shale samples from the Lower Carboniferous Albert Formation, New Brunswick, Canada. Bulletin of Canadian Petroleun Geology, Vol. 32, No. 1, pp. 38-51.

KING, L.H., 1963. Origin of the Albert Mines oil shale (New Brunswick) and its associated albertite. Canada Department of Mines and Technical Surveys, Mines Brancn, Research Report R115, P. 24.

LAMBE, L.M., 1909. The fish fauna of the Albert shales of New Brunswick. American Journal of Science, Vol 28, pp. 165-174.

LAMBE, L.M., 1910. Paleoniscid fishes from the Albert shales of New Brunswick. Canada Department of Mines, Geological Survey Branch, Memoir 3.

MACAULEY, G., 1981. Geology of the oil shales of Canada. Geological Survey of Canada, Paper 81-25.

MACAULEY, G. and BALL F.D., 1982. Oil shales of the Albert Formation, New Brunswick. New Brunswick Department of Natural Resources, Mineral Resources Branch, Open File 82-12, 173 p.

McCUTCHEON, S.R., 1978. Geology of the Apohaqui-Markhamville area, map area R-25 (21H/11W, 21H/12E). Department of Natural Resources, Mineral Resources Branch, Sussex, New Brunswick. Map Report 78-5.

McCUTCHEON, S.R., 1981. Stratigraphy and paleogeography of the Windsor Group in southern New Brunswick. New Brunswick Department of Natural Resources, Mineral Resources Branch, Open File 81-31, 210 p.

McLEOD, M.J., 1978. Geology and mineral deposits of the Dorchester area, map area W-22 ; W-23 (21 H/15E, 21 H/16W). New Brunswick Department of Natural Resources, Mineral Resources Branch, Map Report 78-4, 27 p.

McLEOD, M.J., 1980. Geology and mineral deposits of the Dorchester area, map area V-22 ; V-23 (21 H/15E, 21 H/16W). New Brunswick Department of Natural Resources, Mineral Resources Branch, Map Report 79-6, 35 p..

NORMAN, G.W.H., 1932. Stratigraphy of the Stoney Creek oil and gas field, N.B.; In Oil and Gas in Eastern Canada. Geological Survey of Canada, Economic Geology Series no. 9 (Report no. 2294), pp. 167-173.

NORMAN, G.W.H., 1941. Hillsborough sheet, Albert and Westmorland Counties, New Brunswick. Geological Survey of Canada, Map 647A, with descriptive notes.

PICKERILL, R.K. and CARTER, D.C., 1980. Sedimentary facies and depositional history of the Albert Formation. New Brunswick Department of Natural Resources, Open File Report 80-2.

PICKERILL, R.K. and CARTER, D.C., 1985. Lithostratigraphy of the Late Devonian - Early Carboniferous Horton Group of the Moncton Subbasin, southern New Brunswick. Maritime Sediments and Atlantic Geology, Vol. 21.

PICKERILL, R.K., CARTER, D.C., and ST. PETER, 1985. Albert Shales, Lakes Fans and Deltas. Geological Association of Canada, Fredericton, New Brunswick, Excursion 6

POLL, H.W. van de, 1970. Stratigraphical and sedimentological aspects of Pennsylvanian strata in southern New Brunswick. Unpublished Ph.D. Thesis, University College of Swansa, University of Wales, U.K., 140 p.

ST. PETER, C., 1982. Geology of the Albert Formation, New Brunswick, Canada. 1982 Eastern Oil Shale Symposium; Kentucky Department of Energy and University of Kentucky, Lexington, Kentucky, pp. 39-47.

TIMM, W.B., ALCOCK, F.J., SWINNERTON, A.A. and ELLS, S.C., 1948. Summary of investigations of New Brunswick oil shales. Canada Department of Mines and Resources, Report No. 825.

TISSOT, B.P. and WELTE, D.H., 1974. Oil shales: a kerogen-rich sediment with potential economic value. In Petroleum formation and occurrence - a new approach to oil and gas exploration. Springer Verleg, Berlin, Heidleberg, New York, p. 225-236.

VARMA, C.P., 1969. Lower Carboniferous miospores from the Albert oil shales (Horton Group) of New Brunswick, Canada. Micropaleontology, Vol. 15, pp. 301-324.

WORTH, J., 1975. Final report, Albert Formation, oil shale mapping program. Kings, Albert, and Westmorland Counties, New Brunswick. Fundy Geoservices Ltd., Report for Canadian Occidental Petroleum Ltd..

WORTH, J., 1977. Oil shale and lithofacies, Albert Formation, Hillsborough Subbasin, New Brunswick. Fundy Geoservices Ltd., Report for Canadian Occidential Petroleum Ltd..

WRIGHT, W.J., 1922. Preliminary report on the geology of the Moncton map-area. Geological Survey of Canada, Memoir 129.

YEN, T.F. and CHILINGARIAN, G.V., 1976. Oil shale. In Developments in Petroleum Science, No. 5. Elsevier Scientific Publishing Co., New York, 267 p.

APPENDIX A

LIST OF ABBREVIATIONS USED IN THE LITHOLOGICAL LOGS

APPENDIX A

LIST OF ABBREVIATIONS USED IN THE LITHOLOGICAL LOGS

ABBREVIATION	WORD
abnt	abundant
alt	altered, alteration
amt	amount
ang	angular
av	average
bd	bed(-ded)
bdg	bedding
bit	bitumen(-inous)
blk, blksh	black(-ish)
bm	basement
brec	breccia(-ted)
brn	brown
btm	bottom
bu	buff
calca	calcareous
cg	coarse-grained
cgl	conglomerate(-ic)
cl	clay(-ey)
cmt	cement(-ed,-ing)
com	common
conc	concretion(-ary)
cont	content
cpy	chalcopyrite
cr	crush(-ed)
crbnt	carbonate
ctc	contact
ctous	continuous
disc	discontinuous
dk, dkr	dark(-er)
dns	dense
dol	dolomite
f, fnly	fine(-ly)
fg	fine-grained
flt	fault(-ed)
foss	fossil(-iferous)
frac	fracture(-d)
frag	fragment(-al)
freq	frequent
fspr	feldspar(-athic)
gen	generally
glos	gloss(-y)
gn	galena
gr	grain(-s,-ed)
grd	grade(-d)
grn, grnsh	green(-ish)
grt	granite
gry, grysh	gray, grey(-ish)
gt	grit(-ty)
hem	hematite(-ic)
hi	high(-ly)
hom	homogeneous
incr	increase(-ing)
intbd	interbedded
intrafm	intraformational
intvl(-s)	interval(-s)
ker	kerogen(-ous)
lam	lamina(-tions,-ted)
len, lent	lense, lenticular
lith	lithic
loc	local(-ly)
lstr	lustre
lyr	layer
mass	massive
mg	medium-grained
mnr	minor
mtrx	matrix
nod	nodules(-ar)
num	numerous
p	poor(-ly)
pap	paper(-y)
plas	plastic
pli	paralliel
plt	plant
por,ø	porosity(-ous)
poss	possible(-ly)
pt	part(-ly)
py	pyrite(-itize,-itic)
qtz	quartz(-ose)
r	rate
rem	remains
rnd, rndd	round(-ed)

sc	scales	uncont	unconformity
sd, sdy	sand(-y)	uncons	unconsolidated
sed	sediment(-ary)		
sh	shale(-ly)	v	very
sltst	siltstone	vit	vitreous(-ified)
sml	small	vn	vein(-ing,-ed,-s)
srt, srtg	sorted(-ing)		
ss	sandstone	w/	with
stn	stain(-ed,-ing)		
strgr	stringer(-s)	x-bd	cross-bed(-ded)
thk	thick(-er)	zn	zone
thn	thin		

APPENDIX B

ROCK-EVAL PYROLYSIS, TOTAL ORGANIC CARBON, CARBONATE CARBON AND TOTAL CARBON RESULTS

APPENDIX B - ROCK-EVAL PYROLYSIS, TOTAL ORGANIC CARBON, CARBONATE CARBON AND TOTAL CARBON RESULTS

ROSEVALE NO. 1 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
8696	32.50	33.50	1.00	2.24	18.09	.38	615.30
8697	33.50	34.50	1.00	1.99	25.75	.35	869.93
8698	34.50	35.50	1.00	1.98	26.52	.35	858.25
8699	35.50	36.50	1.00	1.63	26.30	.36	932.60
8700	36.50	37.50	1.00	1.03	21.37	.27	818.77
10201	37.50	38.50	1.00	.65	12.89	.36	596.75
10202	38.50	39.50	1.00	1.47	33.40	.42	930.36
10203	39.50	40.50	1.00	1.41	34.61	.45	1003.18
10204	40.50	41.50	1.00	1.37	13.68	.41	829.09
10205	41.50	42.50	1.00	1.17	13.47	.45	841.87
10206	42.50	43.50	1.00	1.93	28.40	.61	1075.75
10207	43.50	44.50	1.00	1.09	23.96	.53	1079.27
10215	61.50	62.50	1.00	1.80	30.68	.80	1015.87
10216	62.50	63.50	1.00	1.75	33.37	.74	1097.69
10217	63.50	64.50	1.00	1.08	17.01	.74	736.36
10218	64.50	65.50	1.00	1.05	14.36	.75	616.30
10219	65.50	66.50	1.00	1.87	24.75	.88	871.47
10220	66.50	67.50	1.00	2.29	33.49	.75	1011.78
10221	67.50	68.50	1.00	3.26	39.34	.85	1163.90
10222	68.50	69.50	1.00	3.00	20.15	.81	787.10
10223	69.50	70.50	1.00	4.77	39.71	.82	978.07
10224	70.50	71.50	1.00	2.88	27.93	.78	966.43
10225	71.50	72.50	1.00	3.11	29.46	.76	1033.68
10226	72.50	73.50	1.00	3.40	41.14	.76	986.57
10227	73.50	74.50	1.00	3.86	47.00	.67	1060.90
10228	74.50	75.50	1.00	4.07	33.97	.68	1061.56
10229	75.50	76.50	1.00	3.22	48.69	.71	1162.05
10208	87.00	88.00	1.00	2.43	27.89	.94	1186.80
10209	88.00	89.00	1.00	3.85	64.84	1.05	1030.80
10210	89.00	90.00	1.00	3.07	16.23	.80	1008.07
10211	90.00	91.00	1.00	3.09	60.17	.99	986.39
10212	91.00	92.00	1.00	3.19	55.04	.81	1077.10
10213	92.00	93.00	1.00	3.94	62.53	.84	1177.50
10214	93.00	94.00	1.00	2.96	17.28	.72	771.42
8677	105.40	106.00	.60	4.62	48.91	1.20	1124.30
8678	106.00	106.60	.60	5.88	56.89	1.24	1133.20
8679	106.60	107.20	.60	8.43	77.71	.95	1126.26
8680	107.20	107.80	.60	6.13	51.89	.92	1108.76
8681	107.80	108.40	.60	6.56	42.52	1.01	1079.18
8682	108.40	109.00	.60	3.66	17.44	.96	1076.50
8683	109.00	109.60	.60	2.40	9.97	.94	977.45
8684	109.60	110.20	.60	2.16	8.99	.88	817.27
8685	110.20	110.80	.60	2.10	14.48	1.33	952.63
3148	110.80	111.40	.60	2.09	24.46	1.11	837.67
3149	111.40	112.00	.60	4.67	47.13	.79	1172.38

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
12.90	20.33	.11	439	2.94	3.36	6.30
11.80	27.74	.07	440	2.96	2.67	5.63
11.30	28.50	.07	440	3.09	3.17	6.26
12.80	27.93	.06	443	2.82	2.66	5.48
10.30	22.40	.05	441	2.61	2.46	5.07
16.70	13.54	.05	443	2.16	2.88	5.04
11.70	34.87	.04	446	3.59	3.34	6.93
13.00	36.02	.04	443	3.45	2.96	6.41
24.80	15.05	.09	442	1.65	2.37	4.02
28.10	14.64	.08	441	1.60	2.66	4.26
23.10	30.33	.06	444	2.64	3.14	5.78
23.90	25.05	.04	443	2.22	2.76	4.98
26.50	32.48	.06	442	3.02	3.30	6.32
24.30	35.12	.05	444	3.04	3.54	6.58
32.00	18.09	.06	442	2.31	3.27	5.58
32.20	15.41	.07	440	2.33	3.18	5.51
31.00	26.62	.07	440	2.84	3.79	6.63
22.70	35.78	.06	442	3.31	2.07	5.38
25.10	42.60	.08	442	3.38	3.60	6.98
31.60	23.15	.13	440	2.56	3.34	5.90
20.20	44.48	.11	439	4.06	3.19	7.25
27.00	30.81	.09	438	2.89	4.90	7.79
26.70	32.57	.10	440	2.85	4.68	7.53
18.20	44.54	.08	440	4.17	3.71	7.88
15.10	50.86	.08	444	4.43	3.18	7.61
21.30	38.04	.11	441	3.20	3.73	6.93
16.90	51.91	.06	445	4.19	2.93	7.12
40.00	30.32	.08	447	2.35	4.25	6.60
16.70	68.69	.06	446	6.29	4.04	10.33
49.70	19.30	.16	438	1.61	4.08	5.69
16.20	63.26	.05	448	6.10	3.85	9.95
15.90	58.23	.05	448	5.11	3.37	8.48
15.80	66.47	.06	447	5.31	3.81	9.12
32.10	20.24	.15	439	2.24	1.81	4.05
27.60	53.53	.09	444	4.35	5.16	9.51
24.70	62.77	.09	450	5.02	3.34	8.36
13.80	86.14	.10	447	6.90	2.98	9.88
19.70	58.02	.11	446	4.68	3.33	8.01
25.60	49.08	.13	443	3.94	4.18	8.12
59.30	21.10	.17	434	1.62	3.89	5.51
92.20	12.37	.19	432	1.02	2.98	4.00
80.00	11.15	.19	435	1.10	4.26	5.36
87.50	16.58	.13	442	1.52	4.08	5.60
38.00	26.55	.08	446	2.92	2.58	5.50
19.70	51.80	.09	443	4.02	2.30	6.32

APPENDIX B - ROSEVALE NO. 1 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
3150	112.00	112.60	.60	4.63	58.21	1.44	1068.07
3151	112.60	113.20	.60	1.85	26.58	1.56	833.22
3152	113.20	113.80	.60	2.72	41.26	1.48	889.20
3153	113.80	114.40	.60	3.07	37.68	1.66	874.24
3154	114.40	115.00	.60	4.49	45.19	1.40	889.56
3155	115.00	115.60	.60	2.43	28.00	1.77	767.12
3156	115.60	116.20	.60	3.50	46.22	1.78	943.26
3157	116.20	116.80	.60	2.75	25.48	1.67	728.00
3158	116.80	117.40	.60	4.01	30.60	1.82	742.71
3159	117.40	118.00	.60	5.42	42.55	1.51	854.41
3160	118.00	118.60	.60	4.64	56.16	1.48	932.89
3161	118.60	119.20	.60	3.94	56.75	1.34	961.86
3162	119.20	119.80	.60	6.25	119.66	1.32	1060.80
3163	119.80	120.40	.60	1.54	42.38	1.39	917.30
3164	120.40	121.00	.60	3.21	68.02	1.20	1044.85
3165	121.00	121.60	.60	2.31	28.51	.92	1003.87
3166	121.60	122.20	.60	6.27	88.56	1.05	990.60
3167	122.20	122.80	.60	7.85	117.49	1.14	987.31
3168	122.80	123.40	.60	6.87	102.50	1.07	976.19
3169	123.40	124.00	.60	4.46	84.97	1.95	927.60
3170	124.00	124.60	.60	6.06	79.25	.91	985.69
3171	124.60	125.20	.60	5.78	81.57	.86	1004.50
3172	125.20	125.80	.60	1.47	16.63	.77	955.74
8686	125.80	126.40	.60	1.91	10.05	1.15	948.11
8687	126.40	127.00	.60	2.39	12.98	1.47	920.56
3101	127.00	127.60	.60	5.39	101.44	.83	1029.80
3102	127.60	128.20	.60	7.54	124.83	1.00	1088.30
3103	128.20	128.80	.60	5.50	71.49	.68	983.35
3104	128.80	129.40	.60	6.74	118.25	1.04	990.36
3105	129.40	130.00	.60	6.06	68.91	1.22	911.50
3106	130.00	130.60	.60	7.17	93.19	1.14	1034.29
3107	130.60	131.20	.60	6.31	108.79	1.25	1034.10
3108	131.20	131.80	.60	4.81	73.34	1.42	927.18
3109	131.80	132.40	.60	6.33	111.75	1.25	987.19
3110	132.40	133.00	.60	8.60	175.21	1.33	1019.80
3111	133.00	133.60	.60	5.52	72.36	1.13	906.76
3112	133.60	134.20	.60	4.64	78.26	1.41	1035.18
3113	134.20	134.80	.60	3.48	64.10	1.08	1140.56
3114	134.80	135.40	.60	2.32	47.51	1.12	973.56
3115	135.40	136.00	.60	3.36	65.49	1.19	1049.50
3116	136.00	136.60	.60	3.58	76.76	1.21	951.17
3117	136.60	137.20	.60	4.10	98.95	1.35	1115.50
3118	137.20	137.80	.60	4.67	105.94	1.65	1140.36
3119	137.80	138.40	.60	5.14	98.81	1.27	1001.10
3120	138.40	139.00	.60	5.13	75.47	1.46	844.18
3121	139.00	139.60	.60	1.28	13.48	.86	596.46
3122	139.60	140.20	.60	2.52	47.44	1.20	1051.80
3123	140.20	140.80	.60	4.87	64.04	1.46	1192.55

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
26.40	62.84	.07	451	5.45	3.29	8.74
48.90	28.43	.07	448	3.19	3.49	6.68
31.90	43.98	.06	445	4.64	3.57	8.21
38.50	40.75	.08	450	4.31	3.27	7.58
27.60	49.68	.09	446	5.08	3.48	8.56
48.50	30.43	.08	447	3.65	5.55	9.20
36.30	49.72	.07	448	4.90	4.61	9.51
47.70	28.23	.10	447	3.50	5.65	9.15
44.20	34.61	.12	444	4.12	4.19	8.31
30.30	47.97	.11	444	4.98	3.11	8.09
24.60	60.80	.08	446	6.02	2.77	8.79
22.70	60.69	.06	444	5.90	2.01	7.91
11.70	125.91	.05	446	11.28	2.28	13.56
30.10	43.92	.04	450	4.62	5.73	10.35
18.43	71.23	.05	448	6.51	2.48	8.99
32.40	30.82	.07	444	2.84	3.69	6.53
11.70	94.83	.07	443	8.94	4.19	13.13
9.60	125.34	.06	443	11.90	2.08	13.98
10.20	109.37	.06	441	10.50	3.94	14.44
21.30	89.43	.05	441	9.16	3.08	12.24
11.30	85.31	.07	441	8.04	1.68	9.72
10.60	87.35	.07	443	8.12	1.86	9.98
44.30	18.10	.08	440	1.74	2.69	4.43
108.50	11.96	.16	432	1.06	2.21	3.27
104.25	15.37	.16	432	1.41	2.12	3.53
8.40	106.83	.05	445	9.85	2.33	12.18
8.70	132.37	.06	446	11.47	2.41	13.88
9.40	76.99	.07	447	7.27	3.68	10.95
8.70	124.99	.05	442	11.94	2.63	14.57
16.10	74.97	.08	437	7.56	2.46	10.02
12.70	100.36	.07	440	9.01	3.38	12.39
11.90	115.10	.05	444	10.52	3.28	13.80
18.00	78.15	.06	438	7.91	3.82	11.73
11.00	118.08	.05	445	11.32	4.18	15.50
7.70	183.81	.05	445	17.18	1.80	18.98
14.20	77.88	.07	441	7.98	3.52	11.50
18.70	82.90	.06	443	7.56	4.19	11.75
19.20	67.58	.05	444	5.62	4.89	10.51
23.00	49.83	.05	444	4.88	3.75	8.63
19.10	68.85	.05	443	6.24	6.07	12.31
15.00	80.34	.04	442	8.07	4.69	12.76
15.20	103.05	.04	442	8.87	4.89	13.76
17.80	110.59	.04	444	9.29	4.43	13.72
12.90	103.95	.05	441	9.87	3.29	13.16
16.30	80.60	.06	440	8.94	3.01	11.95
38.10	14.76	.09	437	2.26	3.37	5.63
26.60	49.96	.05	443	4.51	3.58	8.09
27.20	68.91	.07	439	5.37	4.31	9.68

APPENDIX B - ROSEVALE NO. 1 GEOCHEMICAL RESULTS

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
3124	140.80	141.40	.60	5.04	70.02	1.68	1014.78
3125	141.40	142.00	.60	4.04	59.16	1.69	743.21
3126	142.00	142.60	.60	2.91	51.98	1.47	842.46
3127	142.60	143.20	.60	6.43	100.58	1.55	1067.70
3128	143.20	143.80	.60	3.94	70.04	1.26	1039.16
3129	143.80	144.40	.60	5.46	94.76	1.26	1113.50
3130	144.40	145.00	.60	4.44	69.92	1.19	841.39
3131	145.00	145.60	.60	4.60	101.86	1.43	977.54
3132	145.60	146.20	.60	1.76	30.24	1.34	739.36
3133	146.20	146.80	.60	.74	13.52	1.45	614.54
3134	146.80	147.40	.60	2.01	29.42	1.65	835.79
3135	147.40	148.00	.60	4.40	42.62	1.63	849.00
3136	148.00	148.60	.60	1.66	20.79	1.82	796.55
3137	148.60	149.20	.60	3.60	50.24	1.85	897.14
3138	149.20	149.80	.60	4.64	79.79	2.00	931.03
3139	149.80	150.40	.60	4.71	105.02	1.83	1125.60
3140	150.40	151.00	.60	3.79	57.07	1.55	978.90
3141	151.00	151.60	.60	7.61	134.01	1.79	1013.69
3142	151.60	152.20	.60	10.02	169.88	1.84	999.88
3143	152.20	152.80	.60	5.65	117.27	1.59	992.97
3144	152.80	153.40	.60	4.12	74.94	1.75	1011.30
3145	153.40	154.00	.60	5.78	76.99	.70	1128.80
3146	154.00	154.60	.60	4.69	93.38	1.47	1191.00
3147	154.60	155.20	.60	3.55	38.61	.75	1191.60
8688	155.20	155.80	.60	1.43	9.54	.33	769.35
8689	155.80	156.40	.60	1.86	13.76	.42	870.88
8690	156.40	157.00	.60	.57	6.30	.44	642.85
8691	157.00	157.60	.60	.53	4.49	.49	724.19
8692	157.60	158.20	.60	1.93	26.51	.21	1199.50
8693	158.20	158.80	.60	4.00	67.15	1.28	1064.18
8694	158.80	159.40	.60	3.23	56.52	1.78	1040.88
8695	159.40	160.00	.60	1.93	16.46	.25	866.31

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
24.30	75.06	.07	439	6.90	4.08	10.98
21.20	63.20	.06	443	7.96	3.04	11.00
23.80	54.89	.05	440	6.17	3.36	9.53
16.50	107.01	.06	439	9.42	4.80	14.22
18.70	73.98	.05	439	6.74	4.08	10.82
14.80	100.22	.05	443	8.51	2.81	11.32
14.30	74.36	.06	440	8.31	1.79	10.10
13.70	106.46	.04	442	10.42	2.46	12.88
32.80	32.00	.06	443	4.09	4.32	8.41
65.90	14.26	.05	440	2.20	10.35	12.55
46.90	31.43	.06	441	3.52	5.31	8.83
32.50	47.02	.09	438	5.02	4.20	9.22
69.70	22.45	.07	439	2.61	3.24	5.85
33.00	53.84	.07	439	5.60	3.00	8.60
23.30	84.43	.05	440	8.57	2.02	10.59
19.60	109.73	.04	445	9.33	3.25	12.58
26.60	60.86	.06	440	5.83	2.73	8.56
13.50	141.62	.05	443	13.22	3.83	17.05
10.80	179.90	.06	446	16.99	2.44	19.43
13.50	122.92	.05	441	11.81	2.27	14.08
23.60	79.06	.05	442	7.41	3.43	10.84
10.30	82.77	.07	442	6.82	1.49	8.31
18.80	98.07	.05	445	7.84	3.20	11.04
23.10	42.16	.08	440	3.24	2.54	5.78
26.60	10.97	.13	441	1.24	1.39	2.63
26.60	15.62	.12	443	1.58	1.44	3.02
44.90	6.87	.08	441	.98	4.05	5.03
79.00	5.02	.11	438	.62	1.42	2.04
9.50	28.44	.07	442	2.21	2.94	5.15
20.30	71.15	.06	447	6.31	4.13	10.44
32.80	59.75	.05	444	5.43	4.45	9.88
13.20	18.39	.10	442	1.90	3.19	5.09

APPENDIX B - ROSEVALE NO. 2 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
8620	28.00	28.60	.60	3.15	39.33	.81	914.65
8621	28.60	29.20	.60	2.55	31.57	1.18	835.18
8622	29.20	29.80	.60	2.90	41.27	.71	996.85
8623	29.80	30.40	.60	2.75	47.61	.92	937.20
8624	30.40	31.00	.60	2.95	61.54	1.20	992.58
8625	31.00	31.60	.60	2.89	42.62	1.00	904.88
8626	31.60	32.20	.60	.46	4.22	.72	458.69
8627	39.00	39.60	.60	2.36	16.46	.95	725.11
8628	39.60	40.20	.60	2.83	44.65	1.19	947.98
8629	40.20	40.80	.60	3.50	64.62	1.09	971.72
8630	40.80	41.40	.60	2.57	55.08	1.08	888.38
8631	41.40	42.00	.60	2.64	58.34	.86	1039.90
8632	42.00	42.60	.60	2.82	74.02	.69	1099.80
8633	42.60	43.20	.60	4.79	110.75	.75	1100.80
8634	43.20	43.80	.60	2.35	3.71	.85	598.38
8635	43.80	44.40	.60	4.16	62.12	.68	1065.50
8636	44.40	45.00	.60	4.08	7.59	.86	722.85
8637	45.00	45.60	.60	2.72	12.61	.75	773.61
8638	45.60	46.20	.60	2.95	45.86	.93	1010.10
8639	46.20	46.80	.60	3.18	38.66	1.01	942.90
8640	46.80	47.40	.60	2.62	24.59	.92	836.39
8641	47.40	48.00	.60	2.99	23.24	.81	806.94
8642	48.00	48.60	.60	2.59	17.28	.78	741.63
8643	48.60	49.20	.60	4.32	80.79	.97	1022.65
8644	49.20	49.80	.60	4.21	106.37	.97	1078.80
8645	49.80	50.40	.60	4.44	70.42	1.10	983.51
8646	50.40	51.00	.60	2.08	26.55	.79	834.90
8647	51.00	51.60	.60	1.56	19.12	.66	758.73
8648	51.60	52.20	.60	.58	6.81	.40	493.47
8649	52.20	52.80	.60	1.92	23.89	.75	835.31
8650	52.80	53.40	.60	3.43	34.96	.63	782.10
8651	53.40	54.00	.60	3.33	24.21	.85	625.58
8652	54.00	54.60	.60	3.36	22.71	.88	751.98
8653	54.60	55.40	.80	2.76	20.05	.87	753.75
8619	55.40	56.00	.60	2.28	12.85	.85	751.46
7642	56.00	56.60	.60	2.63	31.55	1.13	841.33
7643	56.60	57.20	.60	3.06	47.69	1.08	961.49
7644	57.20	57.80	.60	3.84	69.93	1.06	1120.67
7645	57.80	58.40	.60	3.95	65.75	.82	1006.89
7646	58.40	59.00	.60	2.04	27.44	1.27	942.95
7647	59.00	59.60	.60	1.81	12.70	1.08	682.79
7648	59.60	60.20	.60	2.02	26.37	1.13	718.52
7649	60.20	60.80	.60	4.45	94.47	1.42	1066.25
7650	60.80	61.40	.60	5.75	141.26	1.69	1195.09
7651	61.40	62.00	.60	6.61	169.11	1.39	1183.40
7652	62.00	62.60	.60	4.88	110.94	1.44	1196.76
7653	62.60	63.20	.60	6.86	137.91	1.27	1190.90
7654	63.20	63.80	.60	6.85	138.16	1.25	1196.19

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
18.80	42.48	.07	443	4.30	2.95	7.25
31.20	34.12	.07	445	3.78	3.13	6.91
17.10	44.17	.07	443	4.14	3.01	7.15
18.10	50.36	.05	446	5.08	2.80	7.88
19.40	64.49	.05	446	6.20	2.73	8.93
21.20	45.51	.06	446	4.71	3.05	7.76
78.30	4.68	.10	441	.92	4.15	5.07
41.90	18.82	.13	444	2.27	2.56	4.83
25.30	47.48	.06	446	4.71	3.93	8.64
16.40	68.12	.05	448	6.65	2.77	9.42
17.40	57.65	.04	449	6.20	3.30	9.50
15.30	60.98	.04	449	5.61	3.69	9.30
10.30	76.84	.04	451	6.73	2.87	9.60
7.50	115.54	.04	450	10.06	2.89	12.95
137.10	6.06	.39	422	.62	3.59	4.21
11.70	66.28	.06	450	5.83	2.79	8.62
81.90	11.67	.35	424	1.05	2.92	3.97
46.00	15.33	.18	440	1.63	1.11	2.74
20.50	48.81	.06	446	4.54	4.61	9.15
24.60	41.84	.08	443	4.10	4.02	8.12
31.30	27.21	.10	442	2.94	3.39	6.33
28.10	26.23	.11	443	2.88	3.17	6.05
33.50	19.87	.13	442	2.33	2.30	4.63
12.30	85.11	.05	448	7.90	2.08	9.98
9.80	110.58	.04	449	9.86	2.03	11.89
15.40	74.86	.06	445	7.16	2.35	9.51
24.80	28.63	.07	444	3.18	5.21	8.39
26.20	20.68	.08	440	2.52	2.12	4.64
29.00	7.39	.08	442	1.38	1.93	3.31
26.20	25.81	.07	447	2.86	2.62	5.48
14.10	38.39	.09	445	4.47	2.51	6.98
22.00	27.54	.12	442	3.87	2.44	6.31
29.10	26.07	.13	444	3.02	2.49	5.51
32.70	22.81	.12	442	2.66	3.98	6.64
49.70	15.13	.15	444	1.71	3.90	5.61
30.10	34.18	.08	449	3.75	3.63	7.38
21.80	50.75	.06	451	4.96	2.70	7.66
17.00	73.77	.05	451	6.24	4.74	10.98
12.60	69.70	.06	444	6.53	3.35	9.88
43.60	29.48	.07	444	2.91	4.09	7.00
58.10	14.51	.12	443	1.86	2.93	4.79
30.80	28.39	.07	441	3.67	3.33	7.00
16.00	98.92	.04	448	8.86	2.68	11.54
14.30	147.01	.04	447	11.82	4.28	16.10
9.70	175.72	.04	449	14.29	4.64	18.93
15.50	115.82	.04	448	9.27	7.85	17.12
11.00	144.77	.05	448	11.58	4.75	16.33
10.80	145.01	.05	448	11.55	5.65	17.20

APPENDIX B - ROSEVALE NO. 2 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
7655	63.80	64.40	.60	6.45	140.11	.76	1187.37
7656	64.40	65.00	.60	7.15	137.65	1.60	1147.08
7657	65.00	65.60	.60	6.91	118.16	1.12	1080.00
7658	65.60	66.20	.60	6.52	112.11	1.14	1006.37
7659	66.20	66.80	.60	5.68	85.48	1.13	1174.17
7660	66.80	67.40	.60	7.21	121.60	.81	1103.40
7661	67.40	68.00	.60	5.82	101.53	.69	1002.27
7662	68.00	68.60	.60	5.41	100.44	.58	980.85
7663	68.60	69.20	.60	5.03	87.59	.43	1009.10
7664	69.20	69.80	.60	3.00	44.70	.34	1039.50
7665	69.80	70.40	.60	6.59	139.54	.65	1132.60
7666	70.40	71.00	.60	3.33	20.49	.43	706.55
7667	71.00	71.60	.60	8.03	140.93	.50	1116.70
7668	71.60	72.20	.60	5.03	56.93	.34	1020.20
7669	72.20	72.80	.60	3.41	20.40	.40	723.40
7670	72.80	73.40	.60	4.35	39.63	.41	832.56
7671	73.40	74.00	.60	4.36	46.55	.31	895.19
7672	74.00	74.60	.60	4.50	63.49	.38	1034.00
7673	74.60	75.20	.60	1.33	13.48	.37	724.73
7674	75.20	75.80	.60	1.82	13.39	.24	669.50
7675	75.80	76.40	.60	.77	4.82	.12	446.29
7676	76.40	77.00	.60	.51	4.22	.10	435.05
7677	77.00	77.60	.60	.84	6.85	.05	543.65
7678	77.60	78.20	.60	1.18	7.13	.96	685.57
7679	78.20	78.80	.60	.33	1.99	.63	331.66
7680	78.80	79.40	.60	.41	2.36	.79	318.91
7681	79.40	80.00	.60	.40	2.66	.91	354.66
7682	80.00	80.60	.60	.22	1.36	.63	261.53
7683	80.60	81.20	.60	.39	2.23	.93	271.95
7684	81.20	81.80	.60	1.97	20.56	.95	699.31
7685	81.80	82.40	.60	1.93	14.88	.87	644.15
7686	82.40	83.00	.60	1.79	15.33	.94	669.43
7687	83.00	83.60	.60	2.22	31.64	.45	883.79
7688	83.60	84.20	.60	1.86	17.82	.41	778.16
7689	84.20	84.80	.60	3.05	24.37	.48	766.35
7690	84.80	85.40	.60	2.26	26.53	.40	816.30
7691	85.40	86.00	.60	1.70	19.59	.38	714.96
7692	86.00	86.60	.60	1.96	25.64	.45	758.57
7693	86.60	87.20	.60	.54	6.71	.39	419.37
7694	87.20	87.80	.60	.70	5.39	.31	393.43
7695	87.80	88.40	.60	1.16	6.81	.43	417.79
7696	88.40	89.00	.60	2.87	14.19	.49	567.60
7697	89.00	89.60	.60	4.71	63.23	.69	919.04
7698	89.60	90.20	.60	5.37	86.78	.77	1024.55
7699	90.20	90.80	.60	6.93	82.45	.64	1030.60
7700	90.80	91.20	.40	2.83	17.29	.69	642.75
8601	91.20	91.80	.60	2.83	15.67	.57	598.09
8602	91.80	92.40	.60	3.44	32.67	.57	873.52

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
6.40	146.56	.04	449	11.80	5.89	17.69
13.30	144.80	.05	446	12.00	6.54	18.54
10.20	125.07	.06	445	10.94	4.76	15.70
10.20	118.63	.05	444	11.14	4.52	15.66
15.50	91.16	.06	441	7.28	5.99	13.27
7.40	128.81	.06	444	11.02	4.66	15.68
6.80	107.35	.05	443	10.13	1.89	12.02
5.70	105.85	.05	443	10.24	1.71	11.95
5.00	92.62	.05	443	8.68	2.13	10.81
7.90	47.70	.06	445	4.30	1.77	6.07
5.30	146.13	.05	446	12.32	4.28	16.60
14.80	23.82	.14	443	2.90	2.27	5.17
4.00	148.96	.05	445	12.62	4.84	17.46
6.10	61.96	.08	443	5.58	2.72	8.30
14.20	23.81	.14	436	2.82	2.48	5.30
8.60	43.98	.10	442	4.76	2.97	7.73
6.00	50.91	.09	442	5.20	3.04	8.24
6.20	67.99	.07	445	6.14	4.24	10.38
19.90	14.81	.09	443	1.86	3.47	5.33
12.00	15.21	.12	441	2.00	2.35	4.35
11.10	5.59	.14	440	1.08	2.15	3.23
10.30	4.73	.11	439	.97	2.17	3.14
4.00	7.69	.11	441	1.26	1.69	2.95
92.30	8.31	.14	436	1.04	1.87	2.91
105.00	2.32	.14	437	.60	3.29	3.89
106.80	2.77	.15	437	.74	1.48	2.22
121.30	3.06	.13	436	.75	2.27	3.02
121.20	1.58	.14	436	.52	1.81	2.33
113.40	2.62	.15	436	.82	1.60	2.42
32.30	22.53	.09	443	2.94	1.26	4.20
37.70	16.81	.11	442	2.31	1.39	3.70
41.00	17.12	.10	441	2.29	1.27	3.56
12.60	33.86	.07	445	3.58	1.53	5.11
17.90	19.68	.09	444	2.29	2.94	5.23
15.10	27.42	.11	443	3.18	1.66	4.84
12.30	28.79	.08	444	3.25	1.95	5.20
13.90	21.29	.08	444	2.74	1.69	4.43
13.30	27.60	.07	445	3.38	1.80	5.18
24.40	7.25	.07	445	1.60	1.38	2.98
22.60	6.09	.11	440	1.37	1.59	2.96
26.40	7.97	.15	438	1.63	1.77	3.40
19.60	17.06	.17	441	2.50	1.85	4.35
10.00	67.94	.07	448	6.88	2.65	9.53
9.10	92.15	.06	446	8.47	3.79	12.26
8.00	89.38	.08	444	8.00	2.47	10.47
25.70	20.12	.14	443	2.69	2.61	5.30
21.80	18.50	.15	443	2.62	1.65	4.27
15.20	36.11	.10	445	3.74	2.68	6.42

APPENDIX B - ROSEVALE NO. 2 GEOCHEMICAL RESULTS

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
8603	92.40	93.00	.60	4.76	34.25	.71	811.61
8604	93.00	93.60	.60	5.56	14.11	.49	712.60
8605	93.60	94.20	.60	6.55	60.96	.55	955.48
8606	94.20	94.80	.60	2.20	16.89	.88	649.60
8607	94.80	95.40	.60	1.16	9.75	.75	538.67
8608	95.40	96.00	.60	1.44	12.72	.58	629.70
8609	96.00	96.60	.60	.69	4.56	.64	340.29
8610	96.60	97.20	.60	.45	2.74	.52	291.48
8611	97.20	97.80	.60	.50	1.50	.42	288.46
8612	97.80	98.40	.60	.77	2.62	.45	374.28
8613	98.40	99.00	.60	3.44	24.24	.64	752.79
8614	99.00	99.60	.60	5.72	49.97	.80	964.60
8615	99.60	100.20	.60	7.35	72.36	.89	1030.70
8616	100.20	100.80	.60	5.62	49.11	.98	907.76
8617	100.80	101.40	.60	5.02	56.87	.82	1022.80
8618	101.40	102.00	.60	7.91	104.55	.92	1131.40

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
16.80	39.01	.12	445	4.22	2.18	6.40
24.70	19.67	.28	440	1.98	.93	2.91
8.60	67.51	.10	444	6.38	1.90	8.28
33.80	19.09	.12	445	2.60	1.64	4.24
41.40	10.91	.11	443	1.81	1.39	3.20
28.70	14.16	.10	445	2.02	1.83	3.85
47.80	5.25	.13	439	1.34	2.12	3.46
55.30	3.19	.14	442	.94	1.54	2.48
80.80	2.00	.25	441	.52	2.01	2.53
64.30	3.39	.23	443	.70	2.11	2.81
19.90	27.68	.12	446	3.22	1.97	5.19
15.40	55.69	.10	445	5.18	3.96	9.14
12.70	79.71	.09	444	7.02	2.16	9.18
18.10	54.73	.10	442	5.41	1.64	7.05
14.70	61.89	.08	445	5.56	3.07	8.63
10.00	112.46	.07	444	9.24	2.83	12.07

APPENDIX B - ROSEVALE NO. 3 GEOCHEMICAL RESULTS

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
10230	57.00	58.00	1.00	1.01	15.66	.61	649.79
10231	58.00	59.00	1.00	1.38	13.06	.68	624.88
10232	59.00	60.00	1.00	2.20	40.64	.79	1080.85
10233	60.00	61.00	1.00	1.77	42.76	.71	1102.00
10234	61.00	62.00	1.00	1.86	25.04	1.06	840.26
10235	62.00	63.00	1.00	3.84	62.06	.22	1075.56
10236	63.00	64.00	1.00	2.44	39.39	.97	1036.57
10237	64.00	65.00	1.00	4.88	17.76	1.00	792.85
10238	65.00	66.00	1.00	4.18	70.94	1.08	1135.00
10239	74.00	75.00	1.00	4.67	46.33	.83	1048.19
10240	75.00	76.00	1.00	3.92	65.15	.97	1029.20
10241	93.50	94.50	1.00	2.63	34.81	.93	1017.80
10242	94.50	95.50	1.00	2.02	30.66	.82	1102.87
10243	95.50	96.50	1.00	1.66	24.08	.91	1168.90
10244	96.50	97.50	1.00	1.96	24.11	.94	976.11
10245	113.00	114.00	1.00	1.12	19.61	.86	1060.00
10246	114.00	115.00	1.00	1.72	29.59	.28	918.94
10247	115.00	116.00	1.00	1.52	23.68	.33	1020.68
10248	116.00	117.00	1.00	1.61	23.47	.24	1096.70
10249	117.00	118.00	1.00	2.04	32.66	.89	1046.79
10250	118.00	119.00	1.00	2.66	74.84	1.30	1176.70
10251	119.00	120.00	1.00	5.22	81.09	1.03	1115.40
10252	120.00	121.00	1.00	3.66	31.65	.90	904.28
10263	130.00	131.00	1.00	.99	14.66	.89	605.78
10264	131.00	132.00	1.00	1.69	40.01	1.00	985.46
10265	132.00	133.00	1.00	2.66	76.68	1.00	1050.40
10266	133.00	134.00	1.00	3.01	74.38	1.00	982.56
10267	134.00	135.00	1.00	3.04	67.18	.89	1046.40
10268	135.00	136.00	1.00	1.86	49.06	1.00	1090.20
10269	136.00	137.00	1.00	3.47	72.80	.89	1185.66
10270	137.00	138.00	1.00	3.28	28.27	.78	848.94
10271	138.00	139.00	1.00	2.38	14.66	.79	629.18
10272	139.00	140.00	1.00	2.49	14.36	.79	598.33
10273	140.00	141.00	1.00	2.27	15.61	.79	719.35
10274	141.00	142.00	1.00	1.94	24.78	.94	904.37
10275	142.00	143.00	1.00	2.25	27.55	.91	918.33
10276	143.00	144.00	1.00	1.23	17.46	.88	779.46
10277	144.00	145.00	1.00	1.54	33.33	.97	1149.30
10278	145.00	146.00	1.00	2.06	32.74	1.04	779.52
10279	146.00	147.00	1.00	1.63	11.90	1.17	708.33
10280	147.00	148.00	1.00	1.76	8.41	1.25	435.75
10281	148.00	149.00	1.00	2.53	10.54	1.12	452.36
10282	149.00	150.00	1.00	2.81	24.02	1.20	692.21
10283	150.00	151.00	1.00	2.20	20.56	1.09	694.59
10284	151.00	151.50	.50	2.61	37.11	1.05	812.00

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
25.30	16.67	.06	437	2.41	1.73	4.14
32.50	14.44	.10	439	2.09	3.37	5.46
21.00	42.84	.05	441	3.76	2.53	6.29
18.30	44.53	.04	445	3.88	3.53	7.41
35.60	26.90	.07	442	2.98	1.88	4.86
3.80	65.90	.06	439	5.77	4.07	9.84
25.50	41.83	.06	440	3.80	3.51	7.31
44.60	22.64	.22	432	2.24	2.64	4.88
17.30	75.12	.06	440	6.25	4.09	10.34
18.80	51.00	.09	440	4.42	3.91	8.33
15.30	69.07	.06	442	6.33	3.48	9.81
27.20	37.44	.07	438	3.42	4.07	7.49
29.50	32.68	.06	439	2.78	3.98	6.76
44.20	25.74	.06	442	2.06	4.02	6.08
38.10	26.07	.08	440	2.47	4.36	6.83
46.50	20.73	.05	439	1.85	4.34	6.19
8.70	31.31	.05	437	3.22	2.78	6.00
14.20	25.20	.06	438	2.32	3.30	5.62
11.20	25.08	.06	436	2.14	3.20	5.34
28.50	34.70	.06	444	3.12	3.43	6.55
20.40	77.50	.03	448	6.36	3.92	10.28
14.20	86.31	.06	441	7.27	4.26	11.53
25.70	35.31	.10	442	3.50	4.95	8.45
36.80	15.65	.06	440	2.42	2.67	5.09
24.60	41.70	.04	443	4.06	3.26	7.32
13.70	79.34	.03	447	7.30	4.38	11.68
13.20	77.39	.04	446	7.57	3.23	10.80
13.90	70.22	.04	446	6.42	3.64	10.06
22.20	50.92	.04	447	4.50	4.45	8.95
14.50	76.27	.05	444	6.14	4.66	10.80
23.40	31.55	.10	442	3.33	4.58	7.91
33.90	17.04	.14	438	2.33	2.88	5.21
32.90	16.85	.15	440	2.40	3.18	5.58
36.40	17.88	.13	439	2.17	4.31	6.48
34.30	26.72	.07	443	2.74	3.91	6.65
30.30	29.80	.08	443	3.00	4.02	7.02
39.30	18.69	.07	444	2.24	3.94	6.18
33.40	34.87	.04	444	2.90	3.82	6.72
24.80	34.80	.06	440	4.20	3.25	7.45
69.60	13.53	.12	437	1.68	3.71	5.39
64.80	10.17	.17	437	1.93	2.31	4.24
48.10	13.07	.19	439	2.33	3.62	5.95
34.60	26.83	.10	439	3.47	3.11	6.58
36.80	22.76	.10	439	2.96	3.23	6.19
23.00	39.72	.07	441	4.57	2.77	7.34

APPENDIX B - ROSEVALE NO. 4 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
3183	30.00	30.60	.60	1.36	14.74	1.33	643.66
3184	30.60	31.20	.60	1.33	31.51	1.65	870.44
3185	31.20	31.80	.60	1.84	98.12	1.20	1185.00
3186	31.80	32.40	.60	.98	45.53	1.09	1185.67
3187	32.40	33.00	.60	1.62	60.42	1.00	1088.60
3188	33.00	33.60	.60	.81	10.75	.95	617.81
3189	33.60	34.20	.60	1.31	23.16	1.16	815.49
3190	34.20	34.80	.60	.83	16.26	.97	934.48
3191	34.80	35.40	.60	1.43	26.03	.86	813.43
3192	35.40	36.00	.60	.74	11.61	1.25	699.39
3193	36.00	36.60	.60	3.22	46.74	1.20	1011.68
3194	36.60	37.20	.60	3.52	59.13	1.40	1030.10
3195	37.20	37.80	.60	2.86	48.30	1.66	1105.26
3196	37.80	38.40	.60	2.46	25.53	1.31	856.71
3197	38.40	39.00	.60	2.16	36.02	1.27	1000.55
3198	39.00	39.60	.60	1.69	32.76	1.12	957.89
3199	39.60	40.20	.60	2.18	50.02	1.13	996.41
3200	40.20	40.80	.60	2.25	59.94	.99	1037.00
7631	40.80	41.40	.60	.79	25.17	.57	949.81
7630	41.40	42.00	.60	1.16	22.02	.24	754.10
7629	42.00	42.60	.60	.81	33.86	.61	817.87
7628	42.60	43.20	.60	.66	26.57	.51	840.80
7627	43.20	43.80	.60	1.30	31.96	.71	771.98
7626	43.80	44.40	.60	1.52	29.55	.53	805.17
7625	44.40	45.00	.60	.27	.35	.16	106.06
7624	45.00	45.60	.60	1.14	3.90	.72	438.20
7623	45.60	46.20	.60	3.10	8.59	1.06	676.37
7622	46.20	46.80	.60	4.67	6.93	.77	577.50
7621	46.80	47.40	.60	5.30	7.12	.85	556.25
7620	47.40	48.00	.60	6.75	74.63	1.45	1020.90
9899	48.00	48.60	.60	2.78	28.74	1.63	954.80
7619	48.60	49.20	.60	6.29	58.36	1.35	956.72
7618	49.20	49.80	.60	5.96	89.88	1.46	1090.77
7617	49.80	50.40	.60	2.50	45.75	1.16	1191.40
7616	50.40	51.00	.60	4.02	77.54	1.22	1118.90
7615	51.00	51.60	.60	3.10	58.76	1.12	1060.60
7614	51.60	52.20	.60	3.89	72.76	1.22	1126.30
7613	52.20	52.80	.60	7.70	180.68	1.26	1104.40
7612	52.80	53.40	.60	4.70	82.97	1.27	1084.50
7611	53.40	54.00	.60	7.66	159.90	1.12	1135.65
9900	54.00	54.60	.60	5.33	96.18	1.83	1188.87
7610	54.60	55.20	.60	7.50	140.38	1.21	1109.70
7609	55.20	55.80	.60	4.80	65.04	1.19	1037.30
7608	55.80	56.40	.60	6.33	141.51	1.61	1152.36
7607	56.40	57.00	.60	7.01	153.31	1.59	1229.40
7606	57.00	57.60	.60	7.71	146.61	1.79	1178.50
7605	57.60	58.20	.60	7.16	107.33	1.51	1073.30
7604	58.20	58.80	.60	9.34	141.31	1.62	1197.50

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
58.10	16.10	.08	438	2.29	3.46	5.75
45.60	32.84	.04	441	3.62	4.72	8.34
14.50	99.96	.02	450	8.28	3.60	11.88
28.40	46.51	.02	445	3.84	6.40	10.24
18.00	62.04	.03	449	5.55	3.92	9.47
54.60	11.56	.07	440	1.74	3.76	5.50
40.80	24.47	.05	443	2.84	4.16	7.00
55.70	17.09	.05	443	1.74	4.20	5.94
26.90	27.46	.05	441	3.20	3.19	6.39
75.30	12.35	.06	443	1.66	4.13	5.79
26.00	49.96	.06	442	4.62	3.40	8.02
24.40	62.65	.06	445	5.74	3.15	8.89
38.00	51.16	.06	442	4.37	4.25	8.62
44.00	27.99	.09	442	2.98	2.54	5.52
35.30	38.18	.06	442	3.60	3.71	7.31
32.70	34.45	.05	441	3.42	2.47	5.89
22.50	52.20	.04	444	5.02	2.96	7.98
17.10	62.19	.04	443	5.78	3.65	9.43
21.50	25.96	.03	456	2.65	6.14	8.79
8.20	23.18	.05	443	2.92	3.60	6.52
14.70	34.67	.02	458	4.14	3.82	7.96
16.10	27.23	.02	457	3.16	4.71	7.87
17.10	33.26	.04	457	4.14	1.97	6.11
14.40	31.07	.05	459	3.67	1.05	4.72
48.50	.62	.44	429	.33	1.86	2.19
80.90	5.04	.23	450	.89	2.51	3.40
83.50	11.69	.27	435	1.27	2.51	3.78
64.20	11.60	.40	435	1.20	3.31	4.51
66.40	12.42	.43	438	1.28	3.14	4.42
19.80	81.38	.08	446	7.31	1.91	9.22
54.20	31.52	.09	443	3.01	2.42	5.43
22.10	64.65	.10	443	6.10	1.69	7.79
17.70	95.84	.06	447	8.24	3.12	11.36
30.20	48.25	.05	446	3.84	5.63	9.47
17.60	81.56	.05	445	6.93	3.95	10.88
20.20	61.86	.05	446	5.54	2.41	7.95
18.90	76.65	.05	442	6.46	1.90	8.36
7.70	188.38	.04	447	16.36	4.00	20.36
16.60	87.67	.05	445	7.65	3.35	11.00
8.00	167.56	.05	445	14.08	2.80	16.88
22.60	101.51	.05	447	8.09	2.42	10.51
9.60	147.88	.05	448	12.65	1.90	14.55
19.00	69.84	.07	444	6.27	3.27	9.54
13.10	147.84	.04	445	12.28	2.70	14.98
12.80	160.32	.04	448	12.47	4.47	16.94
14.40	154.32	.05	445	12.44	6.16	18.60
15.10	114.49	.06	442	10.00	1.79	11.79
13.70	150.65	.06	444	11.80	2.45	14.25

APPENDIX B - ROSEVALE NO. 4 GEOCHEMICAL RESULTS

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
7603	58.80	59.40	.60	8.44	139.82	1.38	1186.90
7602	59.40	60.00	.60	7.73	139.68	1.55	1244.90
7601	60.00	60.60	.60	8.04	119.02	1.36	1165.70
8503	73.40	74.00	.60	7.12	106.05	1.84	1100.10
8504	74.00	74.60	.60	5.58	58.29	1.56	923.77
8505	81.90	82.50	.60	2.70	28.81	1.03	835.07
8506	82.50	83.10	.60	1.75	20.27	.95	691.80
8507	83.10	83.70	.60	1.55	23.86	.69	806.08
8508	83.70	84.30	.60	1.35	6.76	.37	427.84
8509	84.30	84.90	.60	1.14	5.02	.53	401.60
8510	84.90	85.50	.60	1.26	5.88	.59	405.51
8511	85.50	86.10	.60	1.31	5.28	.61	377.14
8512	86.10	86.70	.60	2.69	10.40	.98	512.31
8513	86.70	87.30	.60	3.23	18.42	2.00	648.59
7632	87.30	87.90	.60	2.64	26.95	.80	824.15
7633	87.90	88.50	.60	3.28	35.52	.81	831.85
7634	88.50	89.10	.60	3.43	36.41	.97	842.82
7635	89.10	89.70	.60	6.09	52.46	.99	860.00
7636	89.70	90.30	.60	5.35	84.90	1.07	1055.90
7637	90.30	90.90	.60	4.37	74.07	.91	995.56
7638	90.90	91.50	.60	2.67	37.59	.88	968.81
7639	91.50	92.10	.60	3.82	76.33	.91	1035.68
7640	92.10	92.70	.60	2.26	23.32	.77	772.18
7641	92.70	93.30	.60	3.29	36.73	1.13	941.79
8654	97.00	97.60	.60	2.44	21.91	1.01	796.72
8655	97.60	98.20	.60	4.08	65.52	1.14	941.37
8656	98.20	98.80	.60	4.76	60.96	.91	911.21
8657	98.80	99.40	.60	3.12	36.38	.90	862.08
8658	99.40	100.00	.60	4.11	45.01	.81	951.58
8659	100.00	100.60	.60	4.75	80.02	.95	1000.25
8660	100.60	101.20	.60	7.67	105.87	.92	1019.90
8661	101.20	101.80	.60	7.35	62.54	.75	957.73
8662	101.80	102.40	.60	9.25	91.46	.69	1074.70
8663	102.40	103.00	.60	4.69	27.64	.56	822.61
8664	103.00	103.60	.60	7.28	72.71	.55	1059.90
8665	103.60	104.20	.60	7.53	56.40	.62	965.75
8666	104.20	104.80	.60	6.04	60.80	.75	912.91
8667	104.80	105.40	.60	7.08	84.91	.69	1010.80
8668	105.40	106.00	.60	5.40	47.44	.65	1049.55
8669	106.00	106.60	.60	5.44	35.01	.80	858.08
8670	106.60	107.20	.60	7.36	85.68	1.03	1095.65
8671	107.20	107.80	.60	4.85	62.62	1.11	1008.30
8672	107.80	108.40	.60	3.08	20.58	1.26	704.79
8673	108.40	109.00	.60	3.43	15.15	1.28	670.35
8674	109.00	109.60	.60	3.56	23.34	1.24	821.83
8675	109.60	110.20	.60	3.51	45.31	1.16	879.80
8676	110.20	110.80	.60	3.54	45.31	1.24	1020.49

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
11.70	148.26	.06	443	11.78	2.46	14.24
13.80	147.41	.05	447	11.22	2.73	13.95
13.30	127.06	.06	446	10.21	2.94	13.15
19.10	113.17	.06	446	9.64	2.15	11.79
24.70	63.87	.09	439	6.31	1.93	8.24
29.90	31.51	.09	438	3.45	.77	4.22
32.40	22.02	.08	439	2.93	1.48	4.41
23.30	25.41	.06	446	2.96	1.30	4.26
23.40	8.11	.17	441	1.58	1.13	2.71
42.40	6.16	.19	438	1.25	2.27	3.52
40.70	7.14	.18	436	1.45	1.23	2.68
43.60	6.59	.20	436	1.40	1.93	3.33
48.30	13.09	.21	438	2.03	1.21	3.24
70.40	21.65	.15	435	2.84	2.26	5.10
24.50	29.59	.09	456	3.27	2.04	5.31
19.00	38.80	.08	455	4.27	3.34	7.61
22.50	39.84	.09	450	4.32	3.08	7.40
16.20	58.55	.10	439	6.10	1.69	7.79
13.30	90.25	.06	452	8.04	3.06	11.10
12.20	78.44	.06	456	7.44	3.13	10.57
22.70	40.26	.07	448	3.88	4.89	8.77
12.30	80.15	.05	459	7.37	2.49	9.86
25.50	25.58	.09	441	3.02	4.58	7.60
29.00	40.02	.08	449	3.90	3.83	7.73
36.70	24.35	.10	440	2.75	4.54	7.29
16.40	69.60	.06	443	6.96	3.26	10.22
13.60	65.72	.07	440	6.69	3.47	10.16
21.30	39.50	.08	442	4.22	5.28	9.50
17.10	49.12	.08	440	4.73	4.75	9.48
11.90	84.77	.06	443	8.00	4.40	12.40
8.90	113.54	.07	440	10.38	3.08	13.46
11.50	69.89	.11	438	6.53	3.42	9.95
8.10	100.71	.09	440	8.51	4.04	12.55
16.70	32.33	.15	434	3.36	2.94	6.30
8.00	79.99	.09	441	6.86	3.79	10.65
10.60	63.93	.12	437	5.84	2.50	8.34
11.30	66.84	.09	439	6.66	2.27	8.93
8.20	91.99	.08	439	8.40	3.06	11.46
14.40	52.84	.10	439	4.52	5.15	9.67
19.60	40.45	.13	436	4.08	4.50	8.58
13.20	93.04	.08	439	7.82	3.37	11.19
17.90	67.47	.07	441	6.21	4.34	10.55
43.20	23.66	.13	439	2.92	2.76	5.68
56.60	18.58	.18	439	2.26	2.76	5.02
43.70	26.90	.13	439	2.84	2.56	5.40
22.50	48.82	.07	439	5.15	2.38	7.53
27.90	48.85	.07	441	4.44	3.92	8.36

APPENDIX B - ROSEVALE NO. 5 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
10253	16.00	17.00	1.00	2.56	58.32	.96	1080.00
10254	17.00	18.00	1.00	1.96	64.16	.87	936.64
10255	18.00	19.00	1.00	2.67	58.07	.28	1025.90
10256	19.00	20.00	1.00	1.97	41.06	.46	970.68
10257	20.00	21.00	1.00	2.85	57.66	.63	964.21
10258	21.00	22.00	1.00	2.31	46.18	.73	927.30
10259	29.00	30.00	1.00	2.56	78.32	1.01	1190.27
10260	30.00	31.00	1.00	2.50	23.58	.80	345.74
10261	31.00	32.00	1.00	1.95	69.19	.92	1008.60
10262	32.00	33.00	1.00	2.29	50.84	.91	987.18
10285	58.00	59.00	1.00	3.65	60.03	.93	948.34
10286	59.00	60.00	1.00	3.94	64.70	.86	1089.20
10287	60.00	61.00	1.00	3.40	75.92	.76	1126.40
10288	61.00	62.00	1.00	3.16	79.94	.82	1203.90
10289	62.00	63.00	1.00	3.15	69.61	.87	1029.70
10290	63.00	64.00	1.00	2.79	68.33	.85	1200.87
10291	66.00	67.00	1.00	2.44	52.77	.76	1022.67
10292	67.00	68.00	1.00	3.88	95.74	.81	1057.90
10293	68.00	69.00	1.00	3.97	89.56	.83	1049.90
10294	69.00	70.00	1.00	3.91	38.98	.77	934.77
10295	133.00	134.00	1.00	1.80	30.96	.99	874.57
10296	134.00	135.00	1.00	2.42	75.34	1.04	1199.68
10297	135.00	136.00	1.00	3.03	71.76	.84	1005.00
10298	136.00	137.00	1.00	3.05	63.09	1.05	1140.86
10299	160.00	161.00	1.00	6.01	82.96	.72	923.83
10300	161.00	162.00	1.00	5.82	79.40	.94	954.32
8501	162.00	163.00	1.00	5.38	73.99	.74	1005.29
8502	163.00	164.00	1.00	4.18	41.20	1.46	925.84
8514	169.50	170.50	1.00	1.59	10.60	1.94	535.35
8515	170.50	171.50	1.00	1.76	13.69	2.22	570.40
8516	171.50	172.50	1.00	5.23	84.28	2.34	1068.18
8517	172.50	173.50	1.00	3.30	40.91	3.10	850.51
8518	173.50	174.50	1.00	3.72	53.81	2.98	940.70
8519	177.00	178.00	1.00	3.63	63.63	3.07	1128.19
8520	178.00	179.00	1.00	3.75	66.44	2.59	1057.90
8521	179.00	180.00	1.00	3.67	57.05	2.34	1072.36
8522	184.00	185.00	1.00	4.66	28.19	2.41	789.63
8523	185.00	186.00	1.00	2.79	15.72	.61	616.47
8524	186.00	187.00	1.00	3.58	25.61	.55	731.71
8525	187.00	188.00	1.00	4.28	27.64	.44	767.77
8526	188.00	189.00	1.00	2.58	5.79	.31	435.33
8527	189.00	190.00	1.00	1.88	6.12	.31	481.88
8528	190.00	191.00	1.00	4.20	55.41	.48	1033.76
8529	191.00	192.00	1.00	4.39	56.84	.52	1025.90
8530	192.00	193.00	1.00	4.39	54.85	.41	993.65
8531	197.00	197.60	.60	3.14	25.33	.41	814.46
8532	197.60	198.20	.60	2.45	19.13	.34	744.35
8533	198.20	198.80	.60	3.17	44.41	.37	959.17

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
17.80	60.88	.04	441	5.40	3.01	8.41
12.70	66.12	.03	446	6.85	3.41	10.26
4.90	60.74	.04	440	5.66	4.46	10.12
10.90	43.03	.05	437	4.23	4.16	8.39
10.50	60.51	.05	443	5.98	2.75	8.73
14.70	48.49	.05	445	4.98	4.28	9.26
15.30	80.88	.03	444	6.58	5.31	11.89
11.70	26.08	.10	443	6.82	4.47	11.29
13.40	71.14	.03	446	6.86	4.16	11.02
17.70	53.13	.04	445	5.15	4.28	9.43
14.70	63.68	.06	442	6.33	2.35	8.68
14.50	68.64	.06	444	5.94	2.82	8.76
11.30	79.32	.04	447	6.74	3.19	9.93
12.30	83.10	.04	446	6.64	3.48	10.12
12.90	72.76	.04	441	6.76	3.22	9.98
14.90	71.12	.04	443	5.69	3.51	9.20
14.70	55.21	.04	444	5.16	3.51	8.67
9.00	99.62	.04	445	9.05	2.40	11.45
9.70	93.53	.04	445	8.53	3.42	11.95
18.50	42.89	.09	438	4.17	3.64	7.81
28.00	32.76	.05	446	3.54	3.91	7.45
16.60	77.76	.03	444	6.28	6.01	12.29
11.80	74.79	.04	446	7.14	3.19	10.33
19.00	66.14	.05	443	5.53	2.80	8.33
8.00	88.97	.07	445	8.98	1.63	10.61
11.30	85.22	.07	443	8.32	3.36	11.68
10.10	79.37	.07	444	7.36	1.40	8.76
32.80	45.38	.09	439	4.45	1.62	6.07
98.00	12.19	.13	436	1.98	1.04	3.02
92.50	15.45	.11	432	2.40	2.08	4.48
29.70	89.51	.06	440	7.89	.86	8.75
64.40	44.21	.07	434	4.81	1.72	6.53
52.10	57.53	.06	434	5.72	2.93	8.65
54.40	67.26	.05	440	5.64	2.66	8.30
41.20	70.19	.05	444	6.28	2.96	9.24
44.00	60.72	.06	443	5.32	3.05	8.37
67.50	32.85	.14	439	3.57	1.67	5.24
23.90	18.51	.15	440	2.55	3.26	5.81
15.70	29.19	.12	441	3.50	1.97	5.47
12.20	31.92	.13	444	3.60	1.99	5.59
23.30	8.37	.31	439	1.33	3.43	4.76
24.40	8.00	.24	437	1.27	3.06	4.33
9.00	59.61	.07	444	5.36	3.81	9.17
9.40	61.23	.07	442	5.54	3.05	8.59
7.40	59.24	.07	445	5.52	2.36	7.88
13.20	28.47	.11	442	3.11	1.96	5.07
13.20	21.58	.11	439	2.57	2.98	5.55
8.00	47.58	.07	445	4.63	3.63	8.26

APPENDIX B - ROSEVALE NO. 5 GEOCHEMICAL RESULTS

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
8534	198.80	199.40	.60	3.24	47.09	.40	983.08
8535	207.00	207.60	.60	2.52	5.67	.30	488.79
8536	207.60	208.20	.60	2.60	20.71	.39	796.53
8537	208.20	208.80	.60	2.45	16.63	.38	780.75
8538	208.80	209.40	.60	2.86	34.04	.34	895.78
8539	209.40	210.00	.60	3.92	49.45	.41	894.21
8540	210.00	210.60	.60	3.39	31.56	.29	925.51
8541	210.60	211.20	.60	3.47	38.05	.28	764.05
8542	211.20	211.80	.60	2.86	26.18	.29	709.48
8543	211.80	212.40	.60	3.15	24.06	1.07	871.73
8544	212.40	213.00	.60	2.83	14.77	1.20	745.95
8545	213.00	213.60	.60	2.86	12.94	1.33	743.67
8546	213.60	214.20	.60	3.44	24.70	1.34	807.18
8547	214.20	214.80	.60	2.90	13.68	1.74	502.94
8548	214.80	215.40	.60	3.71	26.49	1.80	537.30
8549	215.40	216.00	.60	2.45	16.61	1.42	415.25
8550	216.00	216.60	.60	4.06	30.57	1.12	1068.80
8551	216.60	217.20	.60	3.08	25.84	1.40	1123.40
8552	217.20	217.80	.60	1.05	33.29	2.89	1043.50
8553	217.80	218.40	.60	3.89	20.63	1.71	721.30
8554	218.40	219.00	.60	4.20	32.04	1.95	1030.20
8555	219.00	219.60	.60	3.67	26.75	2.08	906.77
8556	219.60	220.20	.60	3.63	26.36	1.61	1098.30
8557	220.20	220.80	.60	3.71	25.99	1.68	254.30
8558	220.80	221.40	.60	6.08	42.07	1.38	823.28
8559	221.40	222.00	.60	3.98	17.04	1.12	624.17

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
8.40	50.33	.06	446	4.79	4.48	9.27
25.90	8.19	.31	436	1.16	1.73	2.88
15.00	23.31	.11	444	2.60	3.25	5.85
17.80	19.08	.13	444	2.13	3.80	5.93
8.90	36.90	.08	447	3.80	4.04	7.84
7.40	53.37	.07	446	5.53	2.87	8.40
8.50	34.95	.10	441	3.41	3.52	6.93
5.60	41.52	.08	442	4.98	4.82	9.80
7.90	29.04	.10	443	3.69	5.09	8.78
38.80	27.21	.12	437	2.76	3.60	6.36
60.60	17.60	.16	437	1.98	3.50	5.48
76.40	15.80	.18	435	1.74	3.77	5.51
43.80	28.14	.12	437	3.06	3.09	6.15
64.00	16.58	.17	433	2.72	4.19	6.91
36.50	30.20	.12	435	4.93	4.31	9.24
35.50	19.06	.13	436	4.00	3.11	7.11
39.20	34.63	.12	438	2.86	3.04	5.90
60.90	28.92	.11	438	2.30	1.97	4.27
90.60	34.34	.03	435	3.19	2.58	5.77
59.80	24.52	.16	437	2.86	2.65	5.51
62.70	36.24	.12	437	3.11	3.13	6.24
70.50	30.42	.12	438	2.95	2.56	5.51
67.10	29.99	.12	436	2.40	2.58	4.98
16.40	29.70	.12	436	10.22	2.63	12.85
27.00	48.15	.13	435	5.11	4.62	9.73
41.00	21.02	.19	431	2.73	3.06	5.79

APPENDIX B - ROSEVALE NO. 6 GEOCHEMICAL RESULTS (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
8560	16.50	17.50	1.00	2.75	23.33	1.60	678.19
8561	17.50	18.50	1.00	2.17	13.84	1.00	736.17
8562	18.50	19.50	1.00	1.52	6.50	1.41	546.21
8563	19.50	20.50	1.00	1.90	12.18	1.59	602.97
8564	32.50	33.50	1.00	2.09	22.71	2.10	723.24
8565	33.50	34.50	1.00	3.27	50.08	1.86	963.07
8566	34.50	35.50	1.00	2.29	21.14	1.53	838.88
8567	35.50	36.50	1.00	2.34	23.91	1.35	1004.60
8568	36.50	37.50	1.00	1.70	12.27	1.70	598.53
8569	37.50	38.50	1.00	2.43	18.69	1.71	618.80
8570	42.50	43.50	1.00	4.89	37.06	2.01	709.96
8571	43.50	44.50	1.00	9.26	93.53	1.91	1015.50
8572	44.50	45.50	1.00	7.09	78.01	1.80	1035.90
8573	45.50	46.50	1.00	5.40	45.83	1.42	866.35
8574	52.00	52.60	.60	3.47	17.50	1.43	538.46
8575	52.60	53.20	.60	4.30	17.34	1.59	555.76
8576	53.20	53.80	.60	1.67	6.99	1.67	428.83
8577	53.80	54.40	.60	5.21	41.33	1.21	793.28
8578	54.40	55.00	.60	1.27	5.55	.51	318.96
8579	55.00	55.60	.60	2.58	15.31	.82	595.71
8580	63.00	63.60	.60	1.22	9.12	.51	430.18
8581	63.60	64.20	.60	1.17	8.89	.50	383.18
8582	64.20	64.80	.60	1.02	5.38	.44	286.17
8583	64.80	65.40	.60	2.65	19.71	.94	617.86
8584	65.40	66.00	.60	3.82	56.96	.82	907.00
8593	68.00	68.60	.60	2.17	10.29	1.04	574.80
8594	68.60	69.20	.60	2.74	41.58	1.20	1058.00
8595	69.20	69.80	.60	5.24	101.56	6.57	1081.57
8596	69.80	70.40	.60	5.63	94.34	.87	1153.30
8597	70.40	71.00	.60	5.56	103.73	.59	1155.10
8598	71.00	71.60	.60	6.31	85.78	.53	1140.60
8599	71.60	72.20	.60	5.00	45.09	.30	1174.20
8600	72.20	72.80	.60	4.99	33.97	.40	1171.37
9801	72.80	73.40	.60	3.75	22.63	.55	794.03
9802	73.40	74.00	.60	3.32	22.35	.47	908.53
9803	74.00	74.60	.60	4.14	32.71	.48	813.68
9804	74.60	75.20	.60	3.10	17.17	.50	643.07
9805	75.20	75.80	.60	3.05	20.06	.49	651.29
9806	75.80	76.40	.60	3.27	18.83	.52	756.22
9807	76.40	77.00	.60	2.38	9.31	.74	460.89
8585	80.50	81.10	.60	2.56	27.50	.63	873.01
8586	81.10	81.70	.60	2.00	13.74	.55	734.75
8587	81.70	82.30	.60	1.25	7.36	.50	327.11
8588	82.30	82.90	.60	1.43	9.45	1.54	502.65
8589	82.90	83.50	.60	2.07	16.26	2.13	658.29
8590	83.50	84.10	.60	2.18	20.25	1.82	703.12
8591	84.10	84.70	.60	2.65	26.45	1.67	745.00
8592	84.70	85.30	.60	3.26	27.59	.48	1037.20

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
46.50	26.08	.11	432	3.44	3.22	6.66
53.20	16.01	.14	434	1.88	3.07	4.95
118.50	8.02	.19	434	1.19	2.47	3.66
78.70	14.08	.13	436	2.02	2.66	4.68
66.90	24.80	.08	435	3.14	1.89	5.03
35.80	53.35	.06	440	5.20	1.97	7.17
60.70	23.43	.10	435	2.52	1.62	4.14
56.70	26.25	.09	438	2.38	2.48	4.86
82.90	13.97	.12	437	2.05	1.78	3.83
56.60	21.12	.12	437	3.02	1.26	4.28
38.50	41.95	.12	439	5.22	1.27	6.49
20.70	102.79	.09	439	9.21	2.60	11.81
23.90	85.10	.08	443	7.53	2.52	10.05
26.80	51.23	.11	440	5.29	3.17	8.46
44.00	20.97	.17	432	3.25	1.65	4.90
51.00	21.64	.20	434	3.12	1.95	5.07
102.50	8.66	.19	434	1.63	2.02	3.65
23.20	46.54	.11	440	5.21	1.07	6.28
29.30	6.82	.19	441	1.74	2.76	4.50
31.90	17.89	.14	440	2.57	2.38	4.95
24.10	10.34	.12	440	2.12	3.17	5.29
21.60	10.06	.12	437	2.32	1.66	3.98
23.40	6.40	.16	438	1.88	2.55	4.43
29.50	22.36	.12	439	3.19	1.86	5.05
13.10	60.78	.06	441	6.28	1.31	7.59
58.10	12.46	.17	440	1.79	1.58	3.37
30.50	44.32	.06	441	3.93	1.83	5.76
70.00	106.80	.05	443	9.39	2.31	11.70
10.60	99.97	.06	441	8.18	.58	8.76
6.60	109.29	.05	441	8.98	3.49	12.47
7.00	92.09	.07	441	7.52	4.97	12.49
7.80	50.09	.10	442	3.84	2.88	6.72
13.80	38.96	.13	442	2.90	3.33	6.23
19.30	26.38	.14	435	2.85	3.48	6.33
19.10	25.67	.13	434	2.46	3.09	5.55
11.90	36.85	.11	435	4.02	3.49	7.51
18.70	20.27	.15	437	2.67	2.18	4.85
15.90	23.11	.13	437	3.08	2.45	5.53
20.90	22.10	.15	437	2.49	4.31	6.80
36.60	11.69	.20	437	2.02	3.89	5.91
20.00	30.06	.09	440	3.15	3.83	6.98
29.40	15.74	.13	441	1.87	2.93	4.80
22.20	8.61	.15	440	2.25	1.60	3.85
81.90	10.88	.13	440	1.88	2.26	4.14
86.20	18.33	.11	441	2.47	2.95	5.42
63.20	22.43	.10	437	2.88	2.27	5.15
47.00	29.10	.09	437	3.55	2.15	5.70
18.00	30.85	.11	437	2.66	2.70	5.36

APPENDIX B - ROSEVALE NO. 6 GEOCHEMICAL RESULTS

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	S1 OIL SHOWS	S2	S3	HYDROGEN INDEX
9808	89.00	89.60	.60	2.58	33.39	.80	822.41
9809	89.60	90.20	.60	2.83	44.07	.85	918.12
9810	90.20	90.80	.60	3.91	70.00	.85	1055.80
9811	90.80	91.40	.60	2.47	31.26	.65	826.98
9812	91.40	92.00	.60	3.15	22.32	.52	817.58
9813	92.00	92.60	.60	2.29	18.92	.59	695.58

APPENDIX B

OXYGEN INDEX	OIL AND GAS POTENTIAL	TRANSFORMATION RATIO	T MAX	TOTAL ORGANIC CARBON	CARBONATE CARBON	TOTAL CARBON
19.70	35.97	.07	444	4.06	2.63	6.69
17.70	46.90	.06	441	4.80	3.29	8.09
12.80	73.91	.05	444	6.63	3.72	10.35
17.20	33.73	.07	439	3.78	2.65	6.43
19.00	25.47	.12	438	2.73	2.90	5.63
21.70	21.21	.11	441	2.72	3.52	6.24

APPENDIX C

CALCULATED SHALE OIL YIELDS

APPENDIX C - CALCULATED SHALE OIL YIELDS

ROSEVALE NO. 1 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8696	32.50	33.50	1.00	26.46	23.00
8697	33.50	34.50	1.00	26.64	31.38
8698	34.50	35.50	1.00	27.81	32.24
8699	35.50	36.50	1.00	25.38	31.60
8700	36.50	37.50	1.00	23.49	25.34
10201	37.50	38.50	1.00	19.44	15.32
10202	38.50	39.50	1.00	32.31	39.45
10203	39.50	40.50	1.00	31.05	40.75
10204	40.50	41.50	1.00	14.85	17.02
10205	41.50	42.50	1.00	14.40	16.56
10206	42.50	43.50	1.00	23.76	34.31
10207	43.50	44.50	1.00	19.98	28.34
10215	61.50	62.50	1.00	27.18	36.74
10216	62.50	63.50	1.00	27.36	39.73
10217	63.50	64.50	1.00	20.79	20.46
10218	64.50	65.50	1.00	20.97	17.43
10219	65.50	66.50	1.00	25.56	30.11
10220	66.50	67.50	1.00	29.79	40.48
10221	67.50	68.50	1.00	30.42	48.19
10222	68.50	69.50	1.00	23.04	26.19
10223	69.50	70.50	1.00	36.54	50.32
10224	70.50	71.50	1.00	26.01	34.85
10225	71.50	72.50	1.00	25.65	36.84
10226	72.50	73.50	1.00	37.53	50.38
10227	73.50	74.50	1.00	39.87	57.53
10228	74.50	75.50	1.00	28.80	43.03
10229	75.50	76.50	1.00	37.71	58.72
10208	87.00	88.00	1.00	21.15	34.30
10209	88.00	89.00	1.00	56.61	77.70
10210	89.00	90.00	1.00	14.49	21.83
10211	90.00	91.00	1.00	54.90	71.56
10212	91.00	92.00	1.00	45.99	65.87
10213	92.00	93.00	1.00	47.79	75.19
10214	93.00	94.00	1.00	20.16	22.90
8677	105.40	106.00	.60	39.15	60.55
8678	106.00	106.60	.60	45.18	71.01
8679	106.60	107.20	.60	62.10	97.44
8680	107.20	107.80	.60	42.12	65.63
8681	107.80	108.40	.60	35.46	55.52
8682	108.40	109.00	.60	14.58	23.87
8683	109.00	109.60	.60	9.18	13.99
8684	109.60	110.20	.60	9.90	12.61
8685	110.20	110.80	.60	13.68	18.76
3148	110.80	111.40	.60	26.28	30.03
3149	111.40	112.00	.60	36.18	58.60

APPENDIX C - ROSEVALE NO. 1 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
3150	112.00	112.60	.60	49.05	71.09
3151	112.60	113.20	.60	28.71	32.16
3152	113.20	113.80	.60	41.76	49.75
3153	113.80	114.40	.60	38.79	46.10
3154	114.40	115.00	.60	45.72	56.20
3155	115.00	115.60	.60	32.85	34.42
3156	115.60	116.20	.60	44.10	56.24
3157	116.20	116.80	.60	31.50	31.93
3158	116.80	117.40	.60	37.08	39.15
3159	117.40	118.00	.60	44.82	54.26
3160	118.00	118.60	.60	54.18	68.78
3161	118.60	119.20	.60	53.10	68.65
3162	119.20	119.80	.60	101.52	142.43
3163	119.80	120.40	.60	41.58	49.68
3164	120.40	121.00	.60	58.59	80.58
3165	121.00	121.60	.60	25.56	34.86
3166	121.60	122.20	.60	80.46	107.27
3167	122.20	122.80	.60	107.10	141.79
3168	122.80	123.40	.60	94.50	123.72
3169	123.40	124.00	.60	82.44	101.17
3170	124.00	124.60	.60	72.36	96.50
3171	124.60	125.20	.60	73.08	98.81
3172	125.20	125.80	.60	15.66	20.48
8686	125.80	126.40	.60	9.54	13.53
8687	126.40	127.00	.60	12.69	17.39
3101	127.00	127.60	.60	88.65	120.85
3102	127.60	128.20	.60	103.23	149.74
3103	128.20	128.80	.60	65.43	87.09
3104	128.80	129.40	.60	107.46	141.39
3105	129.40	130.00	.60	68.04	84.81
3106	130.00	130.60	.60	81.09	113.53
3107	130.60	131.20	.60	94.68	130.20
3108	131.20	131.80	.60	71.19	88.40
3109	131.80	132.40	.60	101.88	133.57
3110	132.40	133.00	.60	154.62	207.93
3111	133.00	133.60	.60	71.82	88.10
3112	133.60	134.20	.60	68.04	93.78
3113	134.20	134.80	.60	50.58	76.45
3114	134.80	135.40	.60	43.92	56.37
3115	135.40	136.00	.60	56.16	77.88
3116	136.00	136.60	.60	72.63	90.88
3117	136.60	137.20	.60	79.83	116.57
3118	137.20	137.80	.60	83.61	125.10
3119	137.80	138.40	.60	88.83	117.59
3120	138.40	139.00	.60	80.46	91.18
3121	139.00	139.60	.60	20.34	16.70
3122	139.60	140.20	.60	40.59	56.52

APPENDIX C - ROSEVALE NO. 1 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
3123	140.20	140.80	.60	48.33	77.95
3124	140.80	141.40	.60	62.10	84.91
3125	141.40	142.00	.60	71.64	71.49
3126	142.00	142.60	.60	55.53	62.09
3127	142.60	143.20	.60	84.78	121.05
3128	143.20	143.80	.60	60.66	83.69
3129	143.80	144.40	.60	76.59	113.37
3130	144.40	145.00	.60	74.79	84.12
3131	145.00	145.60	.60	93.78	120.43
3132	145.60	146.20	.60	36.81	36.20
3133	146.20	146.80	.60	19.80	16.13
3134	146.80	147.40	.60	31.68	35.55
3135	147.40	148.00	.60	45.18	53.19
3136	148.00	148.60	.60	23.49	25.40
3137	148.60	149.20	.60	50.40	60.90
3138	149.20	149.80	.60	77.13	95.51
3139	149.80	150.40	.60	83.97	124.13
3140	150.40	151.00	.60	52.47	68.85
3141	151.00	151.60	.60	118.98	160.20
3142	151.60	152.20	.60	152.91	203.51
3143	152.20	152.80	.60	106.29	139.05
3144	152.80	153.40	.60	66.69	89.43
3145	153.40	154.00	.60	61.38	93.63
3146	154.00	154.60	.60	70.56	110.94
3147	154.60	155.20	.60	29.16	47.69
8688	155.20	155.80	.60	11.16	12.41
8689	155.80	156.40	.60	14.22	17.67
8690	156.40	157.00	.60	8.82	7.77
8691	157.00	157.60	.60	5.58	5.68
8692	157.60	158.20	.60	19.89	32.17
8693	158.20	158.80	.60	56.79	80.49
8694	158.80	159.40	.60	48.87	67.59
8695	159.40	160.00	.60	17.10	20.80

APPENDIX C - ROSEVALE NO. 2 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8620	28.00	28.60	.60	38.70	48.05
8621	28.60	29.20	.60	34.02	38.60
8622	29.20	29.80	.60	37.26	49.97
8623	29.80	30.40	.60	45.72	56.97
8624	30.40	31.00	.60	55.80	72.95
8625	31.00	31.60	.60	42.39	51.48
8626	31.60	32.20	.60	8.28	5.29
8627	39.00	39.60	.60	20.43	21.29
8628	39.60	40.20	.60	42.39	53.71
8629	40.20	40.80	.60	59.85	77.06
8630	40.80	41.40	.60	55.80	65.21
8631	41.40	42.00	.60	50.49	68.98
8632	42.00	42.60	.60	60.57	86.92
8633	42.60	43.20	.60	90.54	130.70
8634	43.20	43.80	.60	5.58	6.86
8635	43.80	44.40	.60	52.47	74.98
8636	44.40	45.00	.60	9.45	13.20
8637	45.00	45.60	.60	14.67	17.34
8638	45.60	46.20	.60	40.86	55.21
8639	46.20	46.80	.60	36.90	47.33
8640	46.80	47.40	.60	26.46	30.78
8641	47.40	48.00	.60	25.92	29.67
8642	48.00	48.60	.60	20.97	22.48
8643	48.60	49.20	.60	71.10	96.28
8644	49.20	49.80	.60	88.74	125.09
8645	49.80	50.40	.60	64.44	84.68
8646	50.40	51.00	.60	28.62	32.39
8647	51.00	51.60	.60	22.68	23.39
8648	51.60	52.20	.60	12.42	8.36
8649	52.20	52.80	.60	25.74	29.20
8650	52.80	53.40	.60	40.23	43.43
8651	53.40	54.00	.60	34.83	31.15
8652	54.00	54.60	.60	27.18	29.49
8653	54.60	55.40	.80	23.94	25.80
8619	55.40	56.00	.60	15.39	17.12
7642	56.00	56.60	.60	33.75	38.67
7643	56.60	57.20	.60	44.64	57.41
7644	57.20	57.80	.60	56.16	83.45
7645	57.80	58.40	.60	58.77	78.85
7646	58.40	59.00	.60	26.19	33.35
7647	59.00	59.60	.60	16.74	16.41
7648	59.60	60.20	.60	33.03	32.12
7649	60.20	60.80	.60	79.74	111.90
7650	60.80	61.40	.60	106.38	166.30
7651	61.40	62.00	.60	128.61	198.78
7652	62.00	62.60	.60	83.43	131.02
7653	62.60	63.20	.60	104.22	163.77

APPENDIX C - ROSEVALE NO. 2 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
7654	63.20	63.80	.60	103.95	164.04
7655	63.80	64.40	.60	106.20	165.79
7656	64.40	65.00	.60	108.00	163.80
7657	65.00	65.60	.60	98.46	141.48
7658	65.60	66.20	.60	100.26	134.20
7659	66.20	66.80	.60	65.52	103.12
7660	66.80	67.40	.60	99.18	145.71
7661	67.40	68.00	.60	91.17	121.44
7662	68.00	68.60	.60	92.16	119.74
7663	68.60	69.20	.60	78.12	104.77
7664	69.20	69.80	.60	38.70	53.96
7665	69.80	70.40	.60	110.88	165.31
7666	70.40	71.00	.60	26.10	26.95
7667	71.00	71.60	.60	113.58	168.51
7668	71.60	72.20	.60	50.22	70.09
7669	72.20	72.80	.60	25.38	26.93
7670	72.80	73.40	.60	42.84	49.75
7671	73.40	74.00	.60	46.80	57.59
7672	74.00	74.60	.60	55.26	76.91
7673	74.60	75.20	.60	16.74	16.75
7674	75.20	75.80	.60	18.00	17.21
7675	75.80	76.40	.60	9.72	6.32
7676	76.40	77.00	.60	8.73	5.35
7677	77.00	77.60	.60	11.34	8.70
7678	77.60	78.20	.60	9.36	9.40
7679	78.20	78.80	.60	5.40	2.62
7680	78.80	79.40	.60	6.66	3.13
7681	79.40	80.00	.60	6.75	3.46
7682	80.00	80.60	.60	4.68	1.79
7683	80.60	81.20	.60	7.38	2.96
7684	81.20	81.80	.60	26.46	25.49
7685	81.80	82.40	.60	20.79	19.02
7686	82.40	83.00	.60	20.61	19.37
7687	83.00	83.60	.60	32.22	38.30
7688	83.60	84.20	.60	20.61	22.26
7689	84.20	84.80	.60	28.62	31.02
7690	84.80	85.40	.60	29.25	32.57
7691	85.40	86.00	.60	24.66	24.08
7692	86.00	86.60	.60	30.42	31.22
7693	86.60	87.20	.60	14.40	8.20
7694	87.20	87.80	.60	12.33	6.89
7695	87.80	88.40	.60	14.67	9.02
7696	88.40	89.00	.60	22.50	19.30
7697	89.00	89.60	.60	61.92	76.86
7698	89.60	90.20	.60	76.23	104.24
7699	90.20	90.80	.60	72.00	101.11
7700	90.80	91.20	.40	24.21	22.76

APPENDIX C - ROSEVALE NO. 2 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8601	91.20	91.80	:60	23.58	20.93
8602	91.80	92.40	.60	33.66	40.85
8603	92.40	93.00	.60	37.98	44.13
8604	93.00	93.60	.60	17.82	22.25
8605	93.60	94.20	.60	57.42	76.37
8606	94.20	94.80	.60	23.40	21.60
8607	94.80	95.40	.60	16.29	12.34
8608	95.40	96.00	.60	18.18	16.02
8609	96.00	96.60	.60	12.06	5.94
8610	96.60	97.20	.60	8.46	3.61
8611	97.20	97.80	.60	4.68	2.26
8612	97.80	98.40	.60	6.30	3.83
8613	98.40	99.00	.60	28.98	31.31
8614	99.00	99.60	.60	46.62	63.00
8615	99.60	100.20	.60	63.18	90.17
8616	100.20	100.80	.60	48.69	61.91
8617	100.80	101.40	.60	50.04	70.01
8618	101.40	102.00	.60	83.16	127.22

APPENDIX C - ROSEVALE NO. 3 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
10230	57.00	58.00	1.00	21.69	18.86
10231	58.00	59.00	1.00	18.81	16.33
10232	59.00	60.00	1.00	33.84	48.46
10233	60.00	61.00	1.00	34.92	50.37
10234	61.00	62.00	1.00	26.82	30.43
10235	62.00	63.00	1.00	51.93	74.55
10236	63.00	64.00	1.00	34.20	47.32
10237	64.00	65.00	1.00	20.16	25.61
10238	65.00	66.00	1.00	56.25	84.98
10239	74.00	75.00	1.00	39.78	57.69
10240	75.00	76.00	1.00	56.97	78.13
10241	93.50	94.50	1.00	30.78	42.35
10242	94.50	95.50	1.00	25.02	36.97
10243	95.50	96.50	1.00	18.54	29.12
10244	96.50	97.50	1.00	22.23	29.49
10245	113.00	114.00	1.00	16.65	23.45
10246	114.00	115.00	1.00	28.98	35.42
10247	115.00	116.00	1.00	20.88	28.51
10248	116.00	117.00	1.00	19.26	28.37
10249	117.00	118.00	1.00	28.08	39.25
10250	118.00	119.00	1.00	57.24	87.67
10251	119.00	120.00	1.00	65.43	97.64
10252	120.00	121.00	1.00	31.50	39.94
10263	130.00	131.00	1.00	21.78	17.70
10264	131.00	132.00	1.00	36.54	47.17
10265	132.00	133.00	1.00	65.70	89.75
10266	133.00	134.00	1.00	68.13	87.55
10267	134.00	135.00	1.00	57.78	79.43
10268	135.00	136.00	1.00	40.50	57.60
10269	136.00	137.00	1.00	55.26	86.28
10270	137.00	138.00	1.00	29.97	35.69
10271	138.00	139.00	1.00	20.97	19.28
10272	139.00	140.00	1.00	21.60	19.06
10273	140.00	141.00	1.00	19.53	20.23
10274	141.00	142.00	1.00	24.66	30.23
10275	142.00	143.00	1.00	27.00	33.71
10276	143.00	144.00	1.00	20.16	21.14
10277	144.00	145.00	1.00	26.10	39.45
10278	145.00	146.00	1.00	37.80	39.37
10279	146.00	147.00	1.00	15.12	15.31
10280	147.00	148.00	1.00	17.37	11.50
10281	148.00	149.00	1.00	20.97	14.79
10282	149.00	150.00	1.00	31.23	30.35
10283	150.00	151.00	1.00	26.64	25.75
10284	151.00	151.50	.50	41.13	44.93

APPENDIX C - ROSEVALE NO. 4 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
3183	30.00	30.60	.60	20.61	18.21
3184	30.60	31.20	.60	32.58	37.15
3185	31.20	31.80	.60	74.52	113.08
3186	31.80	32.40	.60	34.56	52.61
3187	32.40	33.00	.60	49.95	70.18
3188	33.00	33.60	.60	15.66	13.08
3189	33.60	34.20	.60	25.56	27.68
3190	34.20	34.80	.60	15.66	19.33
3191	34.80	35.40	.60	28.80	31.06
3192	35.40	36.00	.60	14.94	13.97
3193	36.00	36.60	.60	41.58	56.52
3194	36.60	37.20	.60	51.66	70.87
3195	37.20	37.80	.60	39.33	57.87
3196	37.80	38.40	.60	26.82	31.66
3197	38.40	39.00	.60	32.40	43.19
3198	39.00	39.60	.60	30.78	38.97
3199	39.60	40.20	.60	45.18	59.05
3200	40.20	40.80	.60	52.02	70.35
7631	40.80	41.40	.60	23.85	29.37
7630	41.40	42.00	.60	26.28	26.22
7629	42.00	42.60	.60	37.26	39.22
7628	42.60	43.20	.60	28.44	30.80
7627	43.20	43.80	.60	37.26	37.62
7626	43.80	44.40	.60	33.03	35.15
7625	44.40	45.00	.60	2.97	.70
7624	45.00	45.60	.60	8.01	5.70
7623	45.60	46.20	.60	11.43	13.22
7622	46.20	46.80	.60	10.80	13.12
7621	46.80	47.40	.60	11.52	14.05
7620	47.40	48.00	.60	65.79	92.06
9899	48.00	48.60	.60	27.09	35.66
7619	48.60	49.20	.60	54.90	73.13
7618	49.20	49.80	.60	74.16	108.42
7617	49.80	50.40	.60	34.56	54.58
7616	50.40	51.00	.60	62.37	92.26
7615	51.00	51.60	.60	49.86	69.98
7614	51.60	52.20	.60	58.14	86.71
7613	52.20	52.80	.60	147.24	213.10
7612	52.80	53.40	.60	68.85	99.17
7611	53.40	54.00	.60	126.72	189.55
9900	54.00	54.60	.60	72.81	114.83
7610	54.60	55.20	.60	113.85	167.29
7609	55.20	55.80	.60	56.43	79.00
7608	55.80	56.40	.60	110.52	167.24
7607	56.40	57.00	.60	112.23	181.36
7606	57.00	57.60	.60	111.96	174.57
7605	57.60	58.20	.60	90.00	129.51

APPENDIX C - ROSEVALE NO. 4 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
7604	58.20	58.80	.60	106.20	170.42
7603	58.80	59.40	.60	106.02	167.71
7602	59.40	60.00	.60	100.98	166.75
7601	60.00	60.60	.60	91.89	143.73
8503	73.40	74.00	.60	86.76	128.02
8504	74.00	74.60	.60	56.79	72.25
8505	81.90	82.50	.60	31.05	35.64
8506	82.50	83.10	.60	26.37	24.91
8507	83.10	83.70	.60	26.64	28.74
8508	83.70	84.30	.60	14.22	9.17
8509	84.30	84.90	.60	11.25	6.97
8510	84.90	85.50	.60	13.05	8.08
8511	85.50	86.10	.60	12.60	7.45
8512	86.10	86.70	.60	18.27	14.81
8513	86.70	87.30	.60	25.56	24.49
7632	87.30	87.90	.60	29.43	33.47
7633	87.90	88.50	.60	38.43	43.89
7634	88.50	89.10	.60	38.88	45.07
7635	89.10	89.70	.60	54.90	66.23
7636	89.70	90.30	.60	72.36	102.09
7637	90.30	90.90	.60	66.96	88.73
7638	90.90	91.50	.60	34.92	45.54
7639	91.50	92.10	.60	66.33	90.67
7640	92.10	92.70	.60	27.18	28.94
7641	92.70	93.30	.60	35.10	45.27
8654	97.00	97.60	.60	24.75	27.55
8655	97.60	98.20	.60	62.64	78.73
8656	98.20	98.80	.60	60.21	74.34
8657	98.80	99.40	.60	37.98	44.68
8658	99.40	100.00	.60	42.57	55.57
8659	100.00	100.60	.60	72.00	95.89
8660	100.60	101.20	.60	93.42	128.44
8661	101.20	101.80	.60	58.77	79.06
8662	101.80	102.40	.60	76.59	113.93
8663	102.40	103.00	.60	30.24	36.57
8664	103.00	103.60	.60	61.74	90.49
8665	103.60	104.20	.60	52.56	72.32
8666	104.20	104.80	.60	59.94	75.61
8667	104.80	105.40	.60	75.60	104.06
8668	105.40	106.00	.60	40.68	59.77
8669	106.00	106.60	.60	36.72	45.76
8670	106.60	107.20	.60	70.38	105.25
8671	107.20	107.80	.60	55.89	76.32
8672	107.80	108.40	.60	26.28	26.76
8673	108.40	109.00	.60	20.34	21.02
8674	109.00	109.60	.60	25.56	30.43
8675	109.60	110.20	.60	46.35	55.23

APPENDIX C - ROSEVALE NO. 4 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8676	110.20	110.80	.60	39.96	55.26

APPENDIX C - ROSEVALE NO. 5 SHALE OIL YELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
10253	16.00	17.00	1.00	48.60	68.87
10254	17.00	18.00	1.00	61.65	74.80
10255	18.00	19.00	1.00	50.94	68.71
10256	19.00	20.00	1.00	38.07	48.68
10257	20.00	21.00	1.00	53.82	68.45
10258	21.00	22.00	1.00	44.82	54.85
10259	29.00	30.00	1.00	59.22	91.49
10260	30.00	31.00	1.00	61.38	29.50
10261	31.00	32.00	1.00	61.74	80.48
10262	32.00	33.00	1.00	46.35	60.10
10285	58.00	59.00	1.00	56.97	72.04
10286	59.00	60.00	1.00	53.46	77.65
10287	60.00	61.00	1.00	60.66	89.73
10288	61.00	62.00	1.00	59.76	94.00
10289	62.00	63.00	1.00	60.84	82.31
10290	63.00	64.00	1.00	51.21	80.45
10291	66.00	67.00	1.00	46.44	62.45
10292	67.00	68.00	1.00	81.45	112.69
10293	68.00	69.00	1.00	76.77	105.80
10294	69.00	70.00	1.00	37.53	48.52
10295	133.00	134.00	1.00	31.86	37.06
10296	134.00	135.00	1.00	56.52	87.96
10297	135.00	136.00	1.00	64.26	84.60
10298	136.00	137.00	1.00	49.77	74.82
10299	160.00	161.00	1.00	80.82	100.64
10300	161.00	162.00	1.00	74.88	96.40
8501	162.00	163.00	1.00	66.24	89.79
8502	163.00	164.00	1.00	40.05	51.33
8514	169.50	170.50	1.00	17.82	13.79
8515	170.50	171.50	1.00	21.60	17.48
8516	171.50	172.50	1.00	71.01	101.26
8517	172.50	173.50	1.00	43.29	50.01
8518	173.50	174.50	1.00	51.48	65.08
8519	177.00	178.00	1.00	50.76	76.09
8520	178.00	179.00	1.00	56.52	79.40
8521	179.00	180.00	1.00	47.88	68.69
8522	184.00	185.00	1.00	32.13	37.16
8523	185.00	186.00	1.00	22.95	20.94
8524	186.00	187.00	1.00	31.50	33.02
8525	187.00	188.00	1.00	32.40	36.11
8526	188.00	189.00	1.00	11.97	9.47
8527	189.00	190.00	1.00	11.43	9.05
8528	190.00	191.00	1.00	48.24	67.43
8529	191.00	192.00	1.00	49.86	69.26
8530	192.00	193.00	1.00	49.68	67.01
8531	197.00	197.60	.60	27.99	32.21
8532	197.60	198.20	.60	23.13	24.41

APPENDIX C - ROSEVALE NO. 5 SHALE OIL YELDS CALCULATED USING TWO METHODS OF CONVERSION

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8533	198.20	198.80	.60	41.67	53.82
8534	198.80	199.40	.60	43.11	56.93
8535	207.00	207.60	.60	10.44	9.26
8536	207.60	208.20	.60	23.40	26.37
8537	208.20	208.80	.60	19.17	21.58
8538	208.80	209.40	.60	34.20	41.74
8539	209.40	210.00	.60	49.77	60.37
8540	210.00	210.60	.60	30.69	39.54
8541	210.60	211.20	.60	44.82	46.97
8542	211.20	211.80	.60	33.21	32.85
8543	211.80	212.40	.60	24.84	30.78
8544	212.40	213.00	.60	17.82	19.91
8545	213.00	213.60	.60	15.66	17.87
8546	213.60	214.20	.60	27.54	31.83
8547	214.20	214.80	.60	24.48	18.76
8548	214.80	215.40	.60	44.37	34.16
8549	215.40	216.00	.60	36.00	21.56
8550	216.00	216.60	.60	25.74	39.17
8551	216.60	217.20	.60	20.70	32.71
8552	217.20	217.80	.60	28.71	38.85
8553	217.80	218.40	.60	25.74	27.74
8554	218.40	219.00	.60	27.99	41.00
8555	219.00	219.60	.60	26.55	34.41
8556	219.60	220.20	.60	21.60	33.93
8557	220.20	220.80	.60	91.98	33.60
8558	220.80	221.40	.60	45.99	54.47
8559	221.40	222.00	.60	24.57	23.78

APPENDIX C - ROSEVALE NO. 6 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION (continued)

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8560	16.50	17.50	1.00	30.96	29.50
8561	17.50	18.50	1.00	16.92	18.11
8562	18.50	19.50	1.00	10.71	9.07
8563	19.50	20.50	1.00	18.18	15.93
8564	32.50	33.50	1.00	28.26	28.05
8565	33.50	34.50	1.00	46.80	60.35
8566	34.50	35.50	1.00	22.68	26.50
8567	35.50	36.50	1.00	21.42	29.69
8568	36.50	37.50	1.00	18.45	15.80
8569	37.50	38.50	1.00	27.18	23.89
8570	42.50	43.50	1.00	46.98	47.45
8571	43.50	44.50	1.00	82.89	116.28
8572	44.50	45.50	1.00	67.77	96.27
8573	45.50	46.50	1.00	47.61	57.95
8574	52.00	52.60	.60	29.25	23.72
8575	52.60	53.20	.60	28.08	24.48
8576	53.20	53.80	.60	14.67	9.80
8577	53.80	54.40	.60	46.89	52.65
8578	54.40	55.00	.60	15.66	7.71
8579	55.00	55.60	.60	23.13	20.24
8580	63.00	63.60	.60	19.08	11.70
8581	63.60	64.20	.60	20.88	11.38
8582	64.20	64.80	.60	16.92	7.24
8583	64.80	65.40	.60	28.71	25.29
8584	65.40	66.00	.60	56.52	68.76
8593	68.00	68.60	.60	16.11	14.10
8594	68.60	69.20	.60	35.37	50.14
8595	69.20	69.80	.60	84.51	120.81
8596	69.80	70.40	.60	73.62	113.09
8597	70.40	71.00	.60	80.82	123.63
8598	71.00	71.60	.60	67.68	104.17
8599	71.60	72.20	.60	34.56	56.66
8600	72.20	72.80	.60	26.10	44.07
9801	72.80	73.40	.60	25.65	29.84
9802	73.40	74.00	.60	22.14	29.04
9803	74.00	74.60	.60	36.18	41.69
9804	74.60	75.20	.60	24.03	22.93
9805	75.20	75.80	.60	27.72	26.14
9806	75.80	76.40	.60	22.41	25.00
9807	76.40	77.00	.60	18.18	13.22
8585	80.50	81.10	.60	28.35	34.00
8586	81.10	81.70	.60	16.83	17.81
8587	81.70	82.30	.60	20.25	9.74
8588	82.30	82.90	.60	16.92	12.31
8589	82.90	83.50	.60	22.23	20.74
8590	83.50	84.10	.60	25.92	25.37
8591	84.10	84.70	.60	31.95	32.92

APPENDIX C - ROSEVALE NO. 6 SHALE OIL YIELDS CALCULATED USING TWO METHODS OF CONVERSION

SAMPLE NUMBER	SAMPLE INTERVAL FROM	TO	SAMPLE LENGTH	LITRES/ TONNE (% organic C)	LITRES/ TONNE (sp. gr.)
8592	84.70	85.30	.60	23.94	34.90
9808	89.00	89.60	.60	36.54	40.69
9809	89.60	90.20	.60	43.20	53.05
9810	90.20	90.80	.60	59.67	83.61
9811	90.80	91.40	.60	34.02	38.16
9812	91.40	92.00	.60	24.57	28.81
9813	92.00	92.60	.60	24.48	23.99

MAPS NOT

FILMED

CARTES

OMISES